

3.0. PREDICTING FUTURE HYDROLOGIC CONDITIONS WITH PROJECTS

The effect of the loss of barrier islands and wetlands on the hydrology of the study area was assessed in Step G using a computer model and the forecast future landscape data. This process was repeated in this step to evaluate the hydrologic effects of the two barrier island designs: Alternative 1 and Alternative 2. The wetland landscape data used in the hydrologic assessments were the same as the no-action landscape described in Step G. The barrier island geometries used in the assessments were the geometries shown in Figure 2-2. The landscape and barrier landforms were incorporated into the topographic/bathymetric grids for input to the computer model. The hydrologic model was run for average and extreme conditions for the present landscape and for the two "future with project" barrier conditions. The average conditions included tides and salinity. The extreme conditions were represented by a Category 5 hurricane.

Results of the computer model simulations are presented as two-dimensional maps of selected parameters over the study area and as time series plots for selected locations in the study area. The locations for which time series results were available are listed in Table 3-1 and are shown in Figure 3-1.

Table 3-1. Locations for which time series of the simulations are available.

Number	Name	Grid Number (hort,vert)
1	Amelia	(41, 97)
2	Bully Camp	(111,114)
3	Bayou Penchant	(40,107)
4	Caillou Island	(105,155)
5	Cocodrie	(85,139)
6	Falgout Canal	(78,123)
7	Golden Meadow	(124,126)
8	Houma Navigation Canal	(79,104)
9	Jug Lake	(57,126)
10	Lafitte	(137,90)
11	Lac des Allemands	(93,65)
12	Lake Salvador	(124,86)
13	Leeville	(129,138)
14	Lost Lake	(46,130)
15	Madison Canal	(92,123)
16	Minor's Canal	(71,107)
17	Port Sulphur	(182,115)
18	Saint Mary's Point	(157,118)
19	Sister Lake	(60,141)
20	So. End Bayou Perot	(133,102)
21	Venice	(213,137)

LEGEND

- PARISH BOUNDARY
- INTERSTATE HIGHWAY
- UNITED STATES HIGHWAY
- LOUISIANA STATE HIGHWAY
- WATER LEVEL LOCATION
- CITY

3.1. Set-Up Of The Hydrologic Model

The hydrologic model used to perform the project assessments has been described in detail in the Step B and Step D reports (LADNR 1998b and 1998d). The model was developed by the Federal Emergency Management Agency to predict hurricane flood elevations for the National Flood Insurance Program and has been modified for this study to include several new features such as computations of water salinity.

The computational grids for the model were setup using the LANDSAT land/water images for present and future conditions. The barrier shoreline alternatives were incorporated into the model at a resolution of the grid cells. The model grid size is 1 kilometer (0.62 miles), therefore each model grid cell contains 1,600 LANDSAT pixels. Each of the 1-km (0.62 miles) grid cells had a percent land and water obtained from the number of LANDSAT pixels in each of these two categories. The LANDSAT image was superimposed upon a topographic data set for the study area and an average elevation was computed for each model grid cell. The average grid cell depth or elevation was adjusted to reflect the percentage of land in a given model grid cell. If the grid cell was 100% land, then the land elevation was assigned to the cell. If the cell was 100% water then the water depth was assigned to the cell. When the cell had a percentage of land between 0 and 100, a land or water elevation was assigned that was the weighted average of the land elevation and water depth. The procedure was repeated for the images for years 30 and 100.

The 30- and 100-year topographic/bathymetric grids used for each alternative simulation are shown in Figures 3-2 to 3-6. The "land" areas have a land percentage that is 41% or greater. Cells having a land percentage that is between zero and 40% are "water". Changes in the amount and distribution of emergent wetlands can be seen in the grids, such as in the areas surrounding Bayou Lafourche and Madison Canal.

Hydrologic parameters were simulated for average tidal flooding, tidal driven salinity and hurricane flooding. Each of these conditions was run for present, 30-, and

100-year landscape conditions. The simulations were run using the barrier shoreline configurations for no-action, Alternative 1 and Alternative 2. The Davis Pond diversion is an authorized federal project for which simulations of the diversion were run for both operational and non-operational periods. The no-action alternative was rerun because some of the original runs were based on a coarser computational grid.

Figure 3-2. Topography (Present)

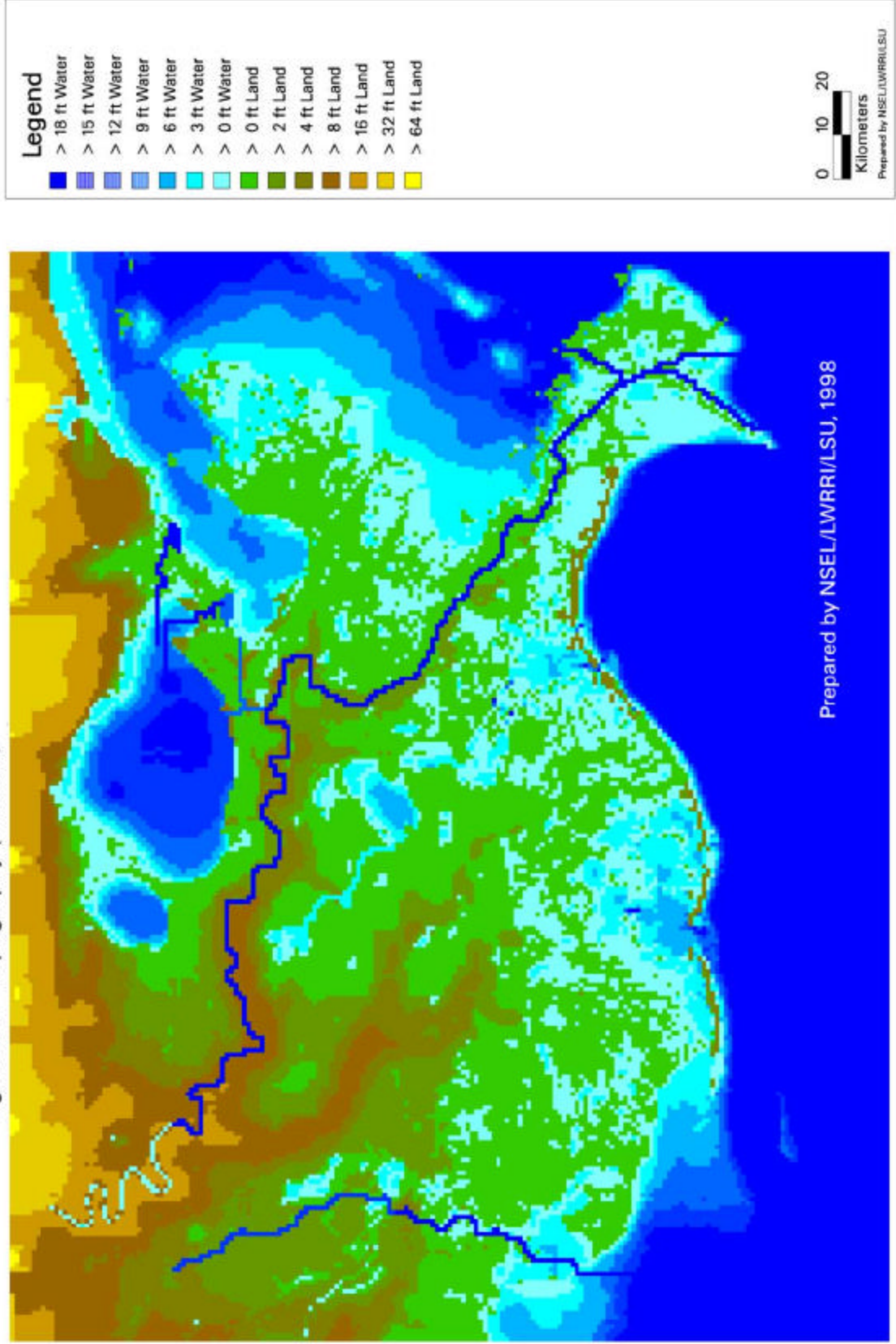


Figure 3-3. Topography (30-Year, Alternative 1)

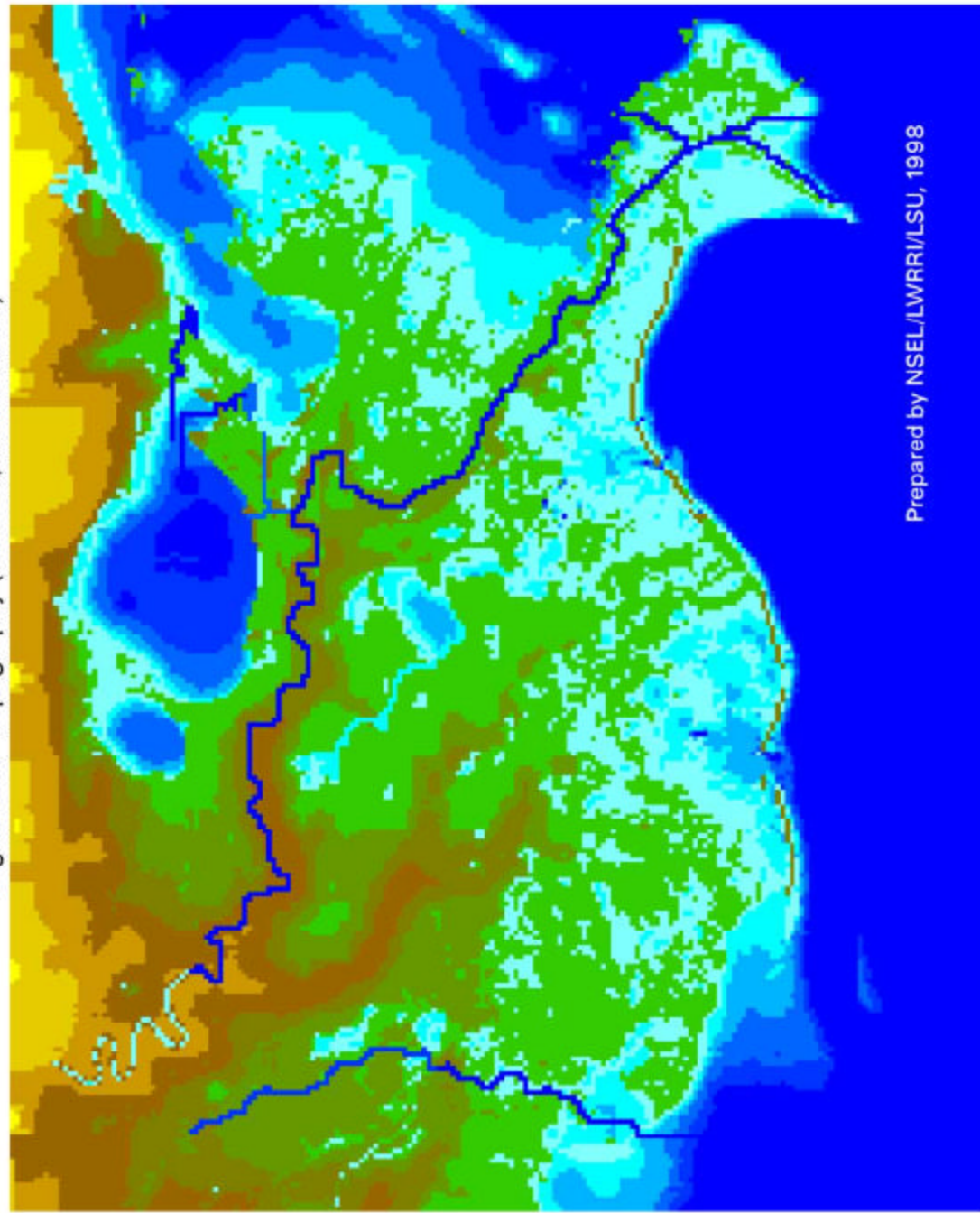


Figure 3-4. Topography (100-Year, Alternative 1)

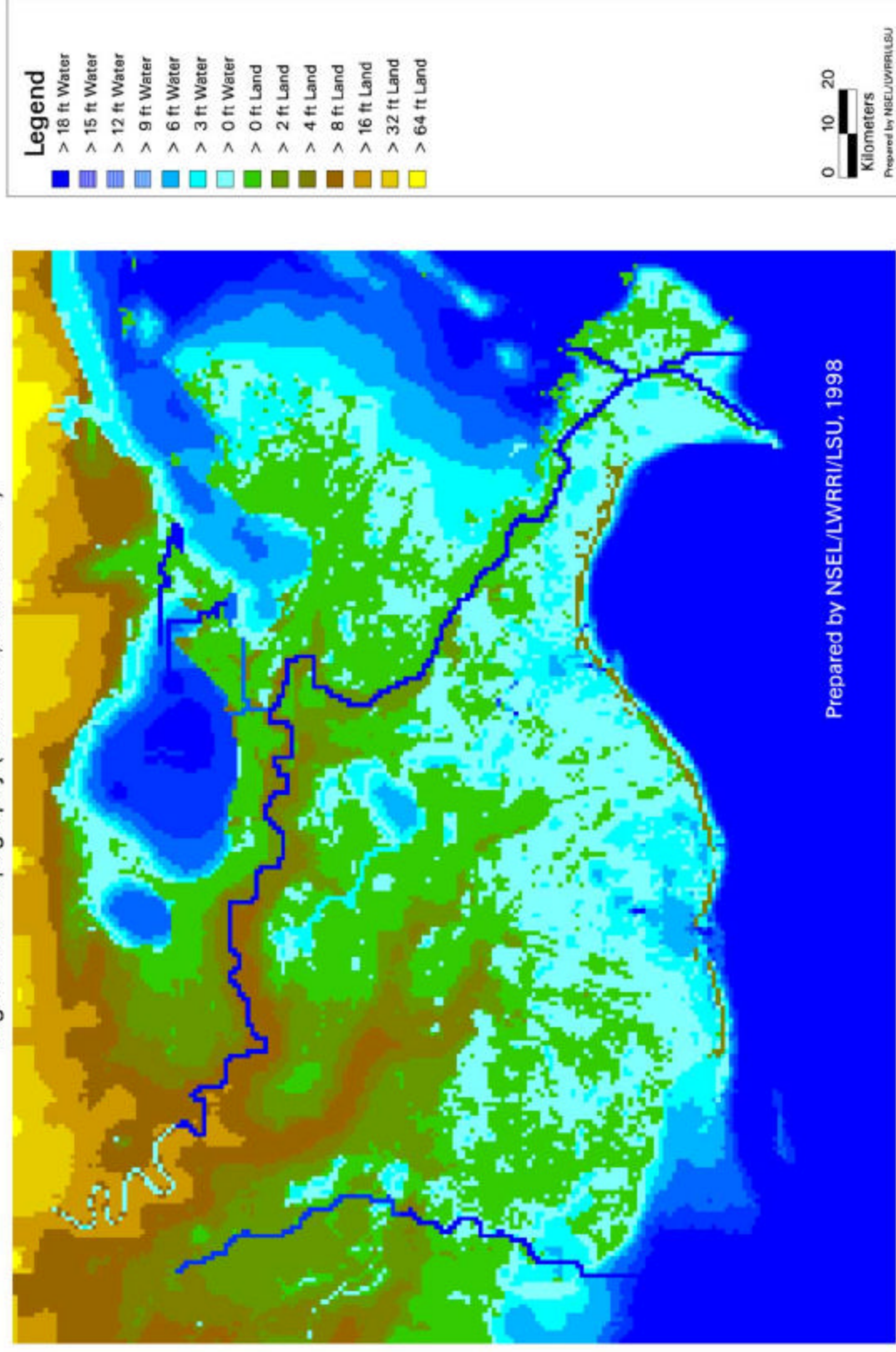


Figure 3-5. Topography (30-Year, Alternative 2)

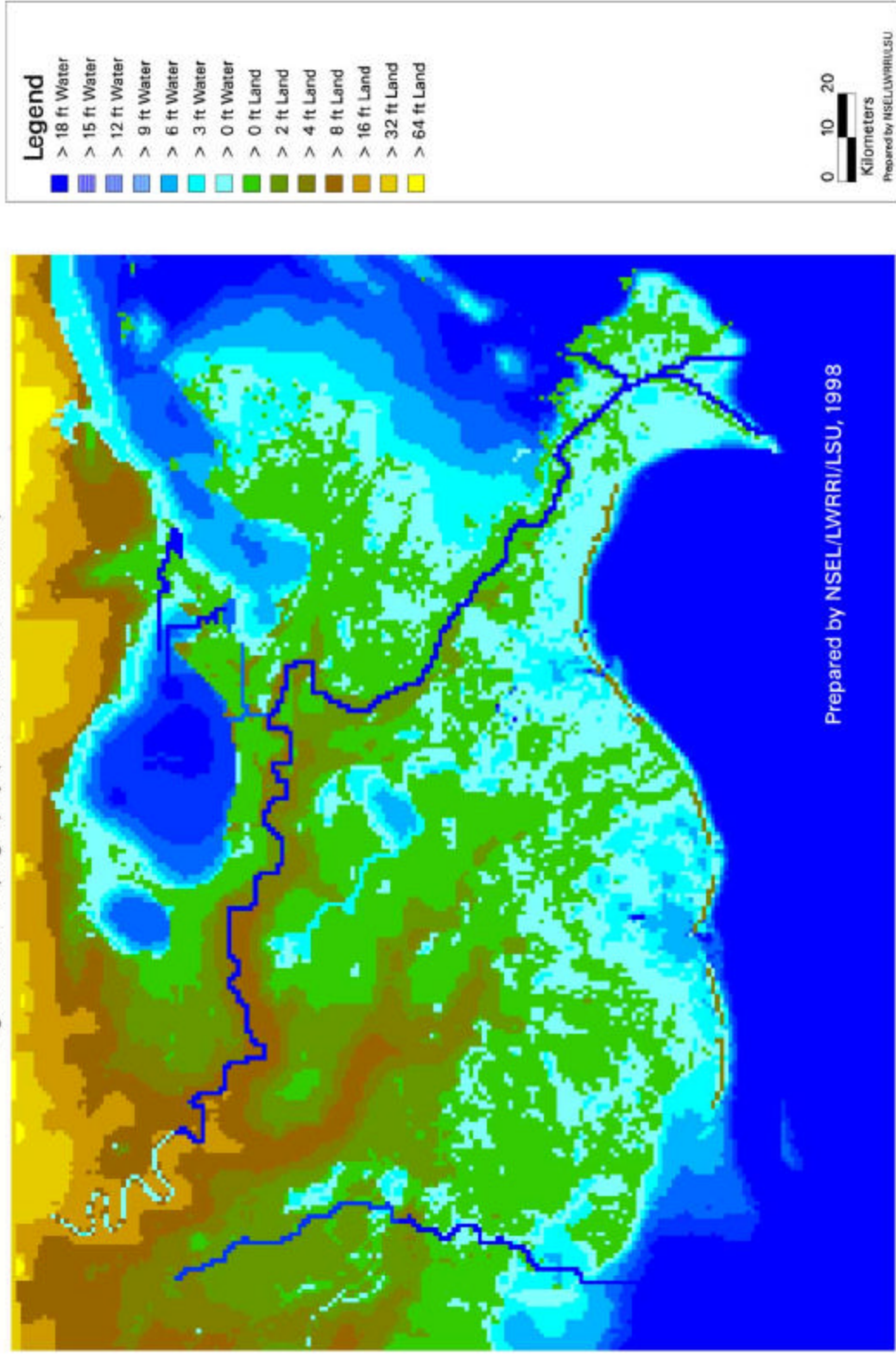
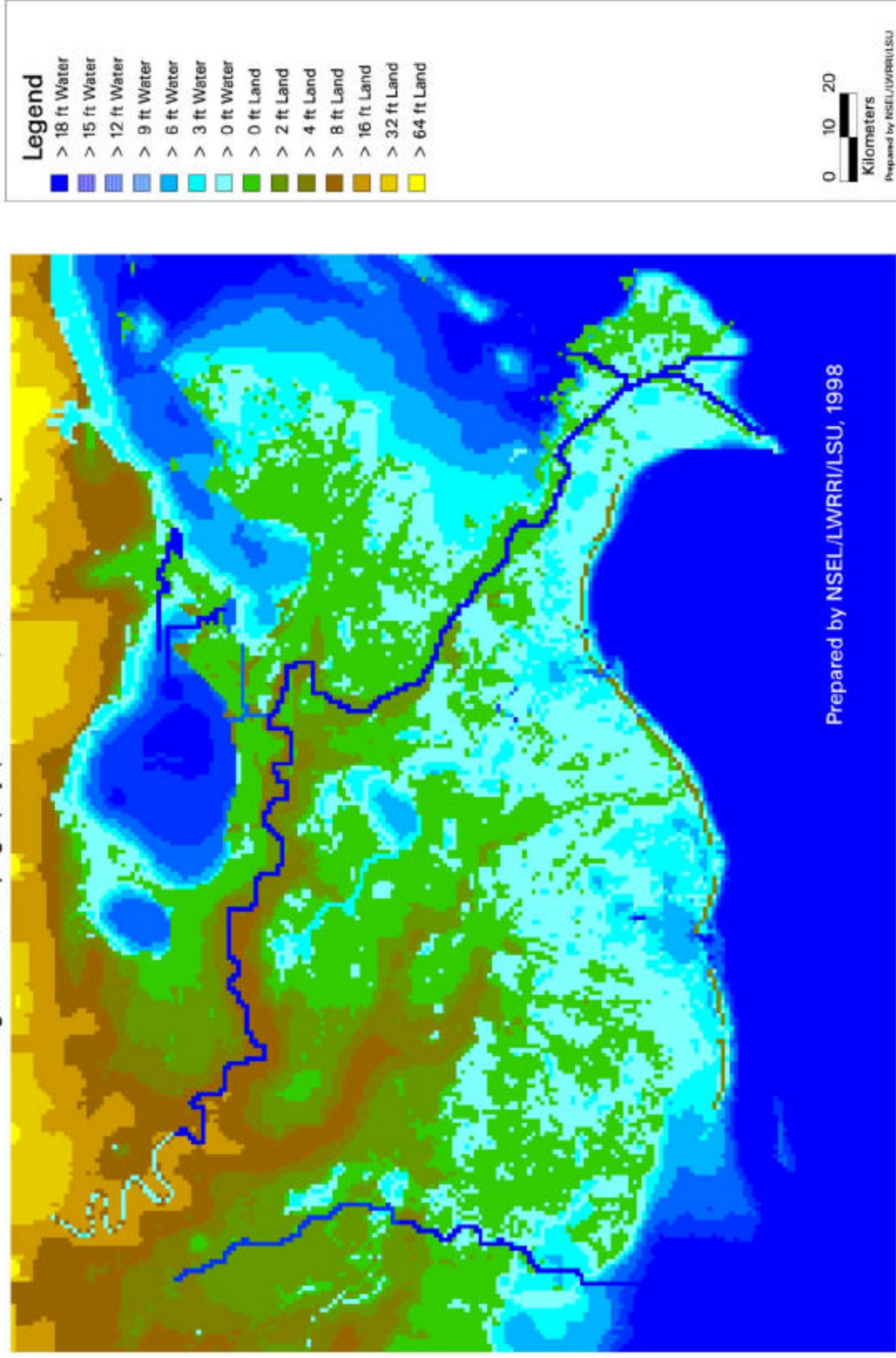


Figure 3-6. Topography (100-Year, Alternative 2)



3.2. RESULTS

The results of the hydrologic simulations are presented in a series of maps and time series graphs. The maps provide a spatial description, in a two-dimensional format, of the results of a simulation. The time series graphs show the temporal variation of a parameter at a particular location over the duration of the simulation. The locations of the time series points are shown in Figure 3-1.

3.2.1. Tide Simulations

Assessments of the effects of barrier island alternatives on average water level conditions were made by running the hydrologic model with average tides. A tidal amplitude of 0.20 meters (0.66 feet) for the Gulf of Mexico for a period of 84 hours was used. The effects of winds are not included in the tidal simulations.

3.2.1.1. No-action

Tidal simulations for the present, 30-, and 100-year no-action alternative at Caillou Island and St. Mary's Point are shown in Figures 3-7 to 3-12. The no-action simulations show that a slight change in tidal amplitude and flooding in the future will occur as a result of wetland and barrier island loss. Areas flooded by average tidal movement generally increase for future conditions. Tidal amplitude within the Barataria Basin fluctuates from about 0.20 meters (0.66 feet) at St. Mary's Point increases to about 0.05 metes (0.16 feet) in Lake Salvador. For future conditions, the tidal amplitude at St. Mary's Points increases to 0.21 meters (0.69 feet) in 30-years and 0.22 meters (0.72 feet) in 100-years. The amplitude in Lake Salvador increases to 0.08 meters (0.26 feet) in 30-years and 0.10 meters (0.33 feet) in 100-years.

3.2.1.2. Alternatives 1 and 2

The tidal simulations indicate that the barrier alternatives will have an overall effect of slightly decreasing tidal amplitude in the study area. The simulation results for all sites are summarized in Table 3-2. The Table indicates that for 11 sites that are flooded currently, 8 sites will experience a decrease, while 3 sites will remain unchanged. Alternative 1 produces more instances of decrease than Alternative 2.

The magnitudes of the changes resulting from the alternatives can be seen by examining actual time series of water elevations. Figures 3.7 and 3.8 show the effect of Alternative 1 on tidal amplitudes for the present configuration for St. Mary's Point and Caillou Island, respectively. The decrease in amplitude is about 1 to 2 cm (0.4 to 0.8 inches) at St. Mary's Point (Fig. 3-7) and Caillou Island (Fig. 3-8). The tidal simulations for the 30-year configuration are shown in Figures 3-9 to 3-10. Alternative 2 produces essentially the same tidal amplitude as the no action alternative with the exception of St. Mary's Point (Fig. 3-10), which shows a small decrease of about 1 to 2 cm (0.4 to 0.8 inches). Alternative 1 shows a larger decrease for the Caillou Island site of about 3 to 4 cm (1.2 to 1.6 inches). The tidal simulations for the 100-year configuration are shown in Figures 3-11 to 3-12. At St. Mary's Point, Alternative 1 shows a decrease in tidal amplitude. Caillou Island (Fig. 3-12) has a decrease in tidal amplitude of about 1 to 2 cm (0.4 to 0.8 inches). In other areas, such as Falgout Canal, the Houma Navigation Canal at the Intracoastal Waterway, and St. Mary's Point (Fig. 3-11), Alternative 1 shows a decrease of about 5 to 6 cm (2.0 to 2.4 inches). This decrease for Alternative 1 is due to the fact that while the inlets near the barrier islands are constant, the bay area in the study area has increased in 100-years so that a fixed tide is spreading over a larger area. In general, the changes in average tidal amplitude due to Alternatives 1 and 2 were very slight. Table 3-2 shows the overall tidal changes in the time series locations.

Table 3-2. Changes in water level for future projections. X = no change or not flooded. V = flooded and/or change in water level, NC = no change from no action, D =decrease from no action.

Station Name	No-action		Alternative 1		Alternative 2	
	30 yr	100 yr	30 yr	100 yr	30 yr	100 yr
Venice	V	V	NC	NC	NC	NC
Port Sulphur	X	V	X	X	X	D
St. Mary's Point	V	V	D	D	D	NC
Lafitte	X	X	X	X	X	X
Bayou Perot (S)	V	V	NC	NC	NC	NC
Lake Salvador	V	V	D	D	D	D
Leeville	V	V	D	NC	NC	NC
Golden Meadow	X	X	X	X	X	X
Bully Camp	X	V	X	D	X	D
Caillou Island	V	V	D	D	NC	D
Lac des Allemands	V	V	D	D	D	D
Madison Canal	X	X	X	X	X	X
Cocodrie	X	V	X	X	X	X
Falgout Canal1	V	V	NC	D	NC	D
HNC at GIWW	V	V	NC	D	NC	D
Minors Canal	V	V	NC	D	NC	D
Sister Lake	V	V	NC	NC	NC	NC
Jug Lake	V	V	NC	NC	NC	NC
Lost Lake	X	X	X	X	X	X
Bayou Penchant (W)	X	X	X	X	X	X
Amelia	X	X	X	X	X	X

Figure 3-7. Elevation vs. Time (Present)
At St. Marys Point

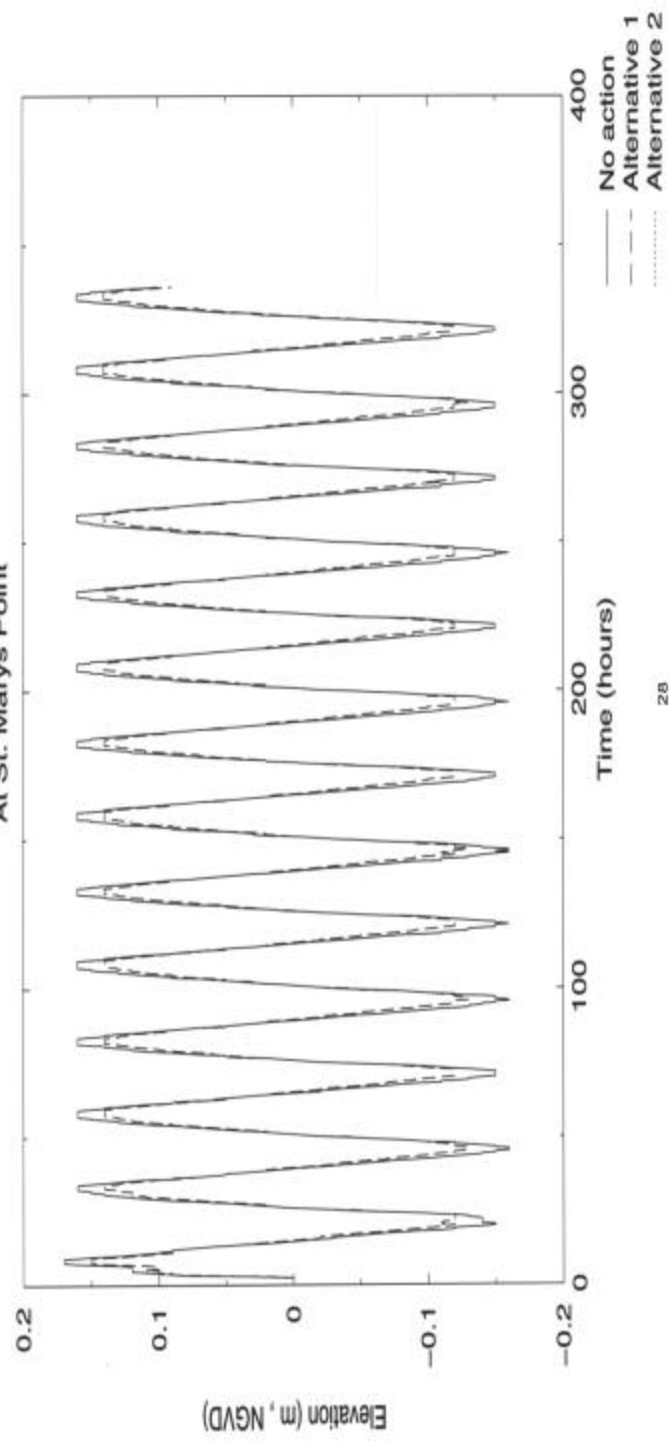


Figure 3-8. Elevation vs. Time (Present)
At Calliou_Island

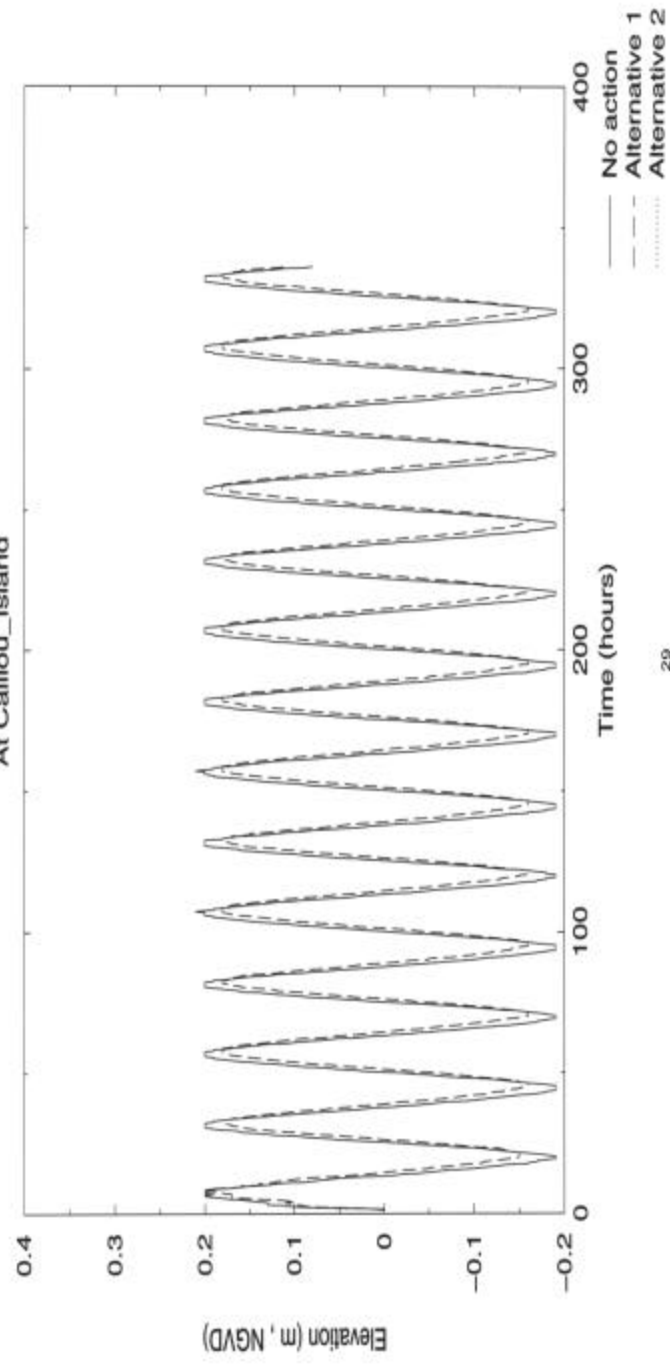


Figure 3-9. Elevation vs. Time (30-Year)
At St. Marys Point

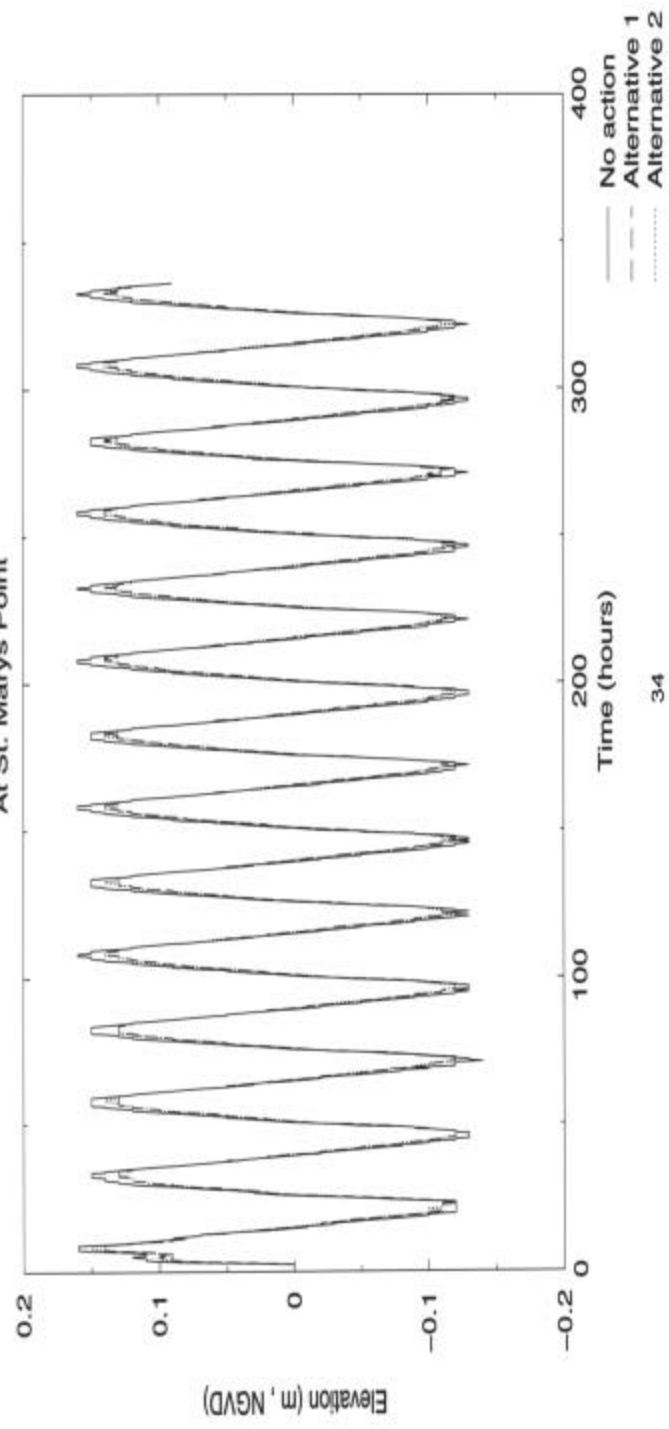


Figure 3-10. Elevation vs. Time (30-Year)

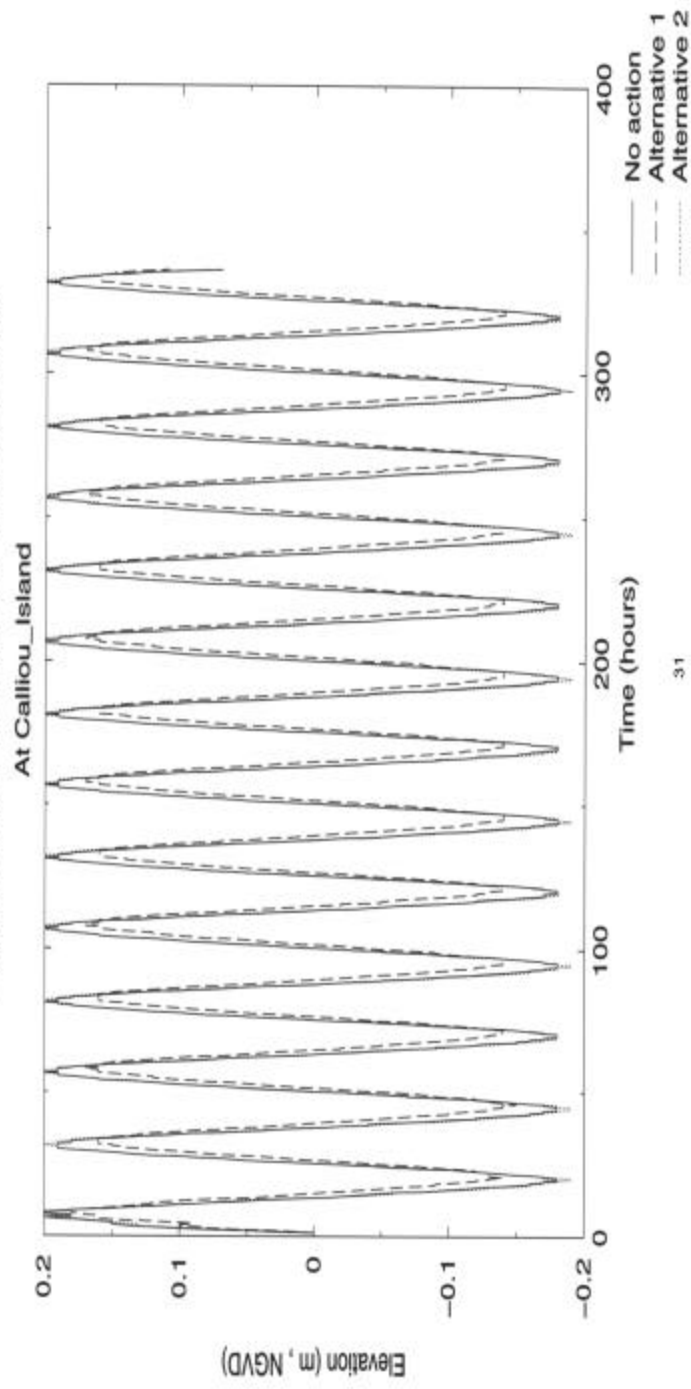


Figure 3-11. Elevation vs. Time (100-Year)
At St. Marys Point

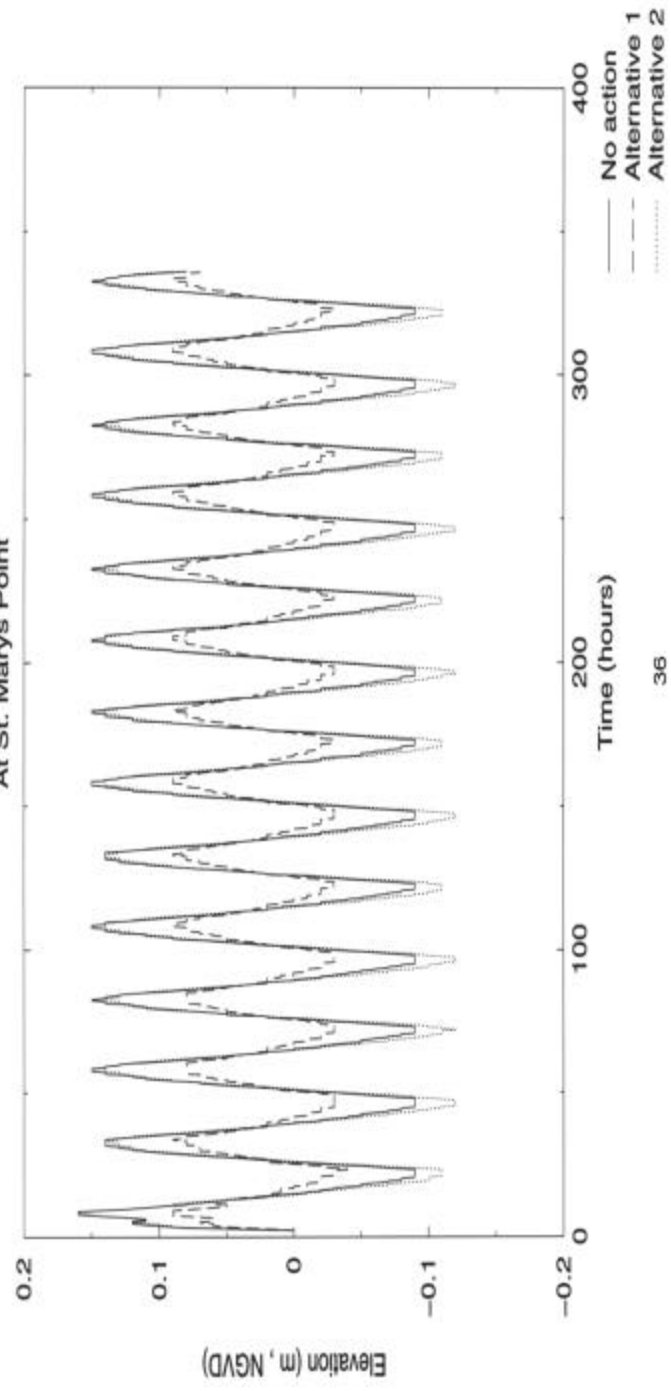
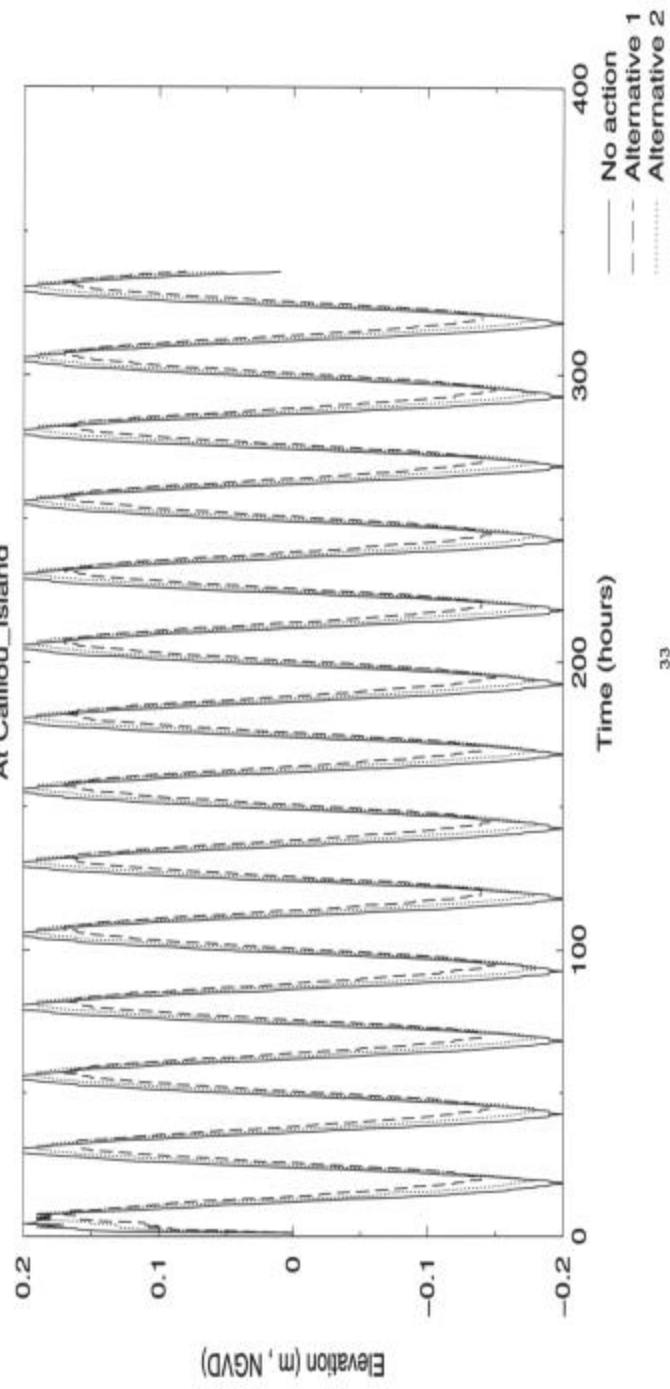


Figure 3-12. Elevation vs. Time (100-Years)
At Calliou_Island



3.2.2. Salinity Simulations

Assessing salinity impacts of Alternatives 1 and 2 in the study area were made by running the hydrologic model for various wetland and barrier configurations. The model was run to simulate a 90-day period of tidal conditions. Winds were not included in the simulations. The no-action wetland configurations for present, 30-, and 100-years were used. Each of the separate barrier shoreline configurations, no-action, Alternative 1 and Alternative 2, were used. Because of the projected operation of the Davis Pond diversion, runs were made for both operational and non-operational periods. The diversion was assumed to be operating a 227 m³/s (8,000-cfs) for the whole 90 day period of the simulation.

The discharge from the Davis Pond Diversion flows southward along the western side of Barataria Bay freshens that side of the bay. The flow and mixing of fresh and salt water on the eastern side of the bay seems to be altered due to the diversion discharge, so that the salinity of the water slightly increases in this area over the period of the simulation.

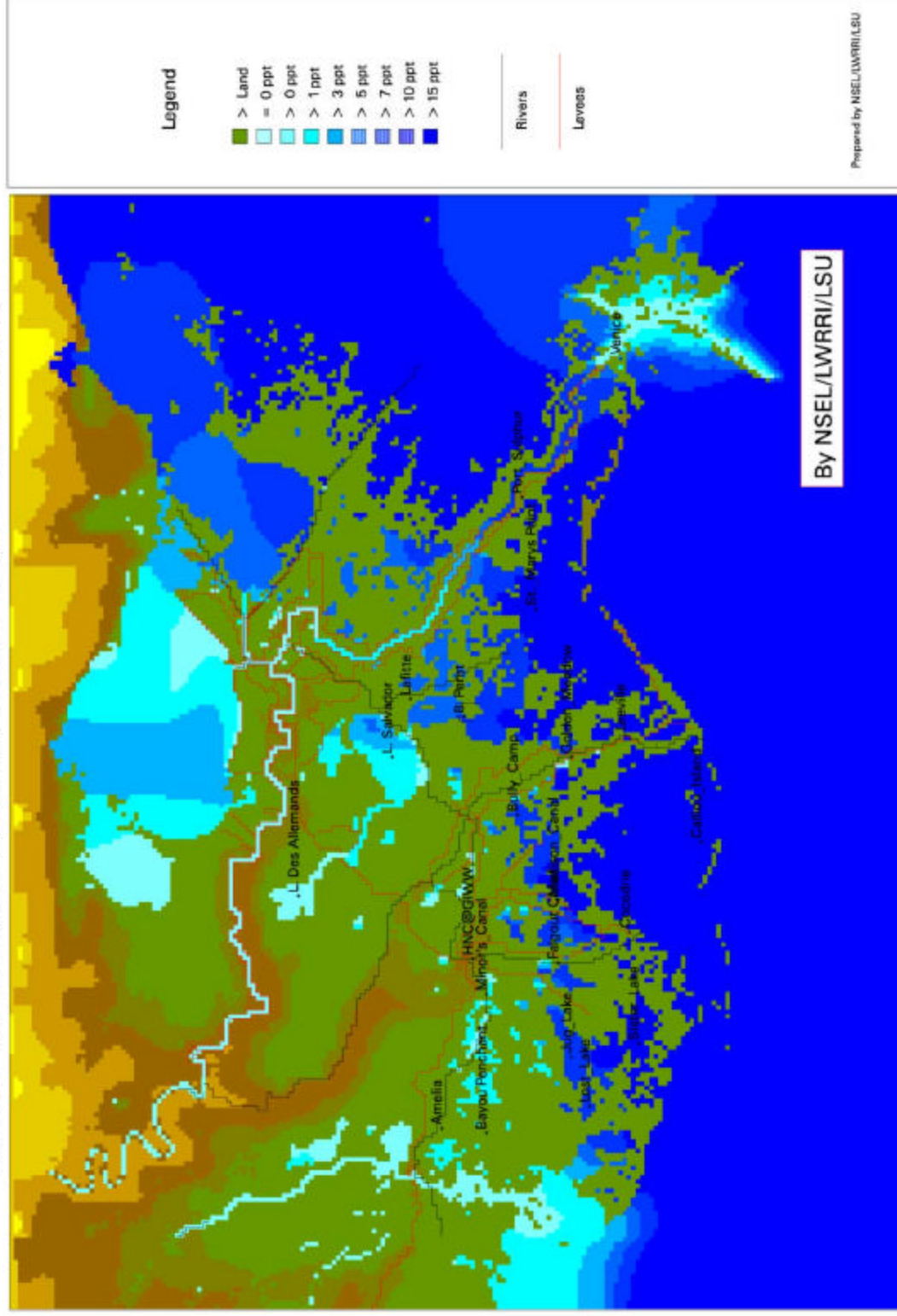
3.2.2.1. No-action

The Davis Pond diversion has a major effect on the salinity in the Barataria Bay portion of the study area comparing the no-action simulations for 30- and 100-years with and without Davis Pond (Figures 3-13 to 3-16). The diversion causes a decrease of up to 10 parts per thousand (ppt) in the salinity in Barataria Bay north of the barrier islands. With the diversion, salinities of less than 1 ppt are predicted to extend southward in the basin to the northern edge of Barataria Bay. Salinities on the eastern side of Barataria Bay do not seem to be strongly influenced by the diversion.

3.2.2.2. Alternative 1

Results of the salinity forecast for Alternative 1 for various scenarios are shown as the difference between the barrier alternative compared to no-action. The results and comparisons of the salinity simulations are presented in Figures 3-17 to 3-20 for no-action, 30- and 100-years, with and without Davis Pond. The results of the salinity simulations indicate the effects of Alternative 1 are generally restricted to areas adjacent to the islands. Figure 3-17, for year 30, shows the salinity differences for Alternative 1 are greatest north of Timbalier Island. Salinities decrease in Terrebonne Bay immediately north of the islands by over 3 ppt. Decreases in salinity also are indicated in Barataria Bay north of Grand Terre and in Caillou Bay north of Isles Dernieres. The salinity decreases are 1 to 2 ppt. Salinities seaward of the barriers show a slight increase in salinity by about 1 ppt due to the barrier islands limiting exchange along the gulfside of the island. For year 100, Figure 3-18, the simulation shows Alternative 1 has a much larger effect north of the Timbalier Islands. A large area of the bay shows a salinity decrease greater than 3 ppt. A slight increase in salinity is indicated near Shell Island. This is due to the reduction of tidal exchange of seawater allowed by Alternative 1 in this area resulting from closure of breaches and erosion associated with no-action. When combined with the Davis Pond diversion, Figures 3-19 and 3-20 show the greatest effect of Alternative 1. A larger area, most of the southern part of Barataria Bay, is indicated to experience a decrease in salinity of over 3 ppt.

Figure 3-13. Salinity Distribution (w/o Davis Pond, 30-Year, No-Action)



Time = 2160 Hr. (90 Days)

Figure 3-14. Salinity Distribution (with Davis Pond, 30-Year, No-Action)

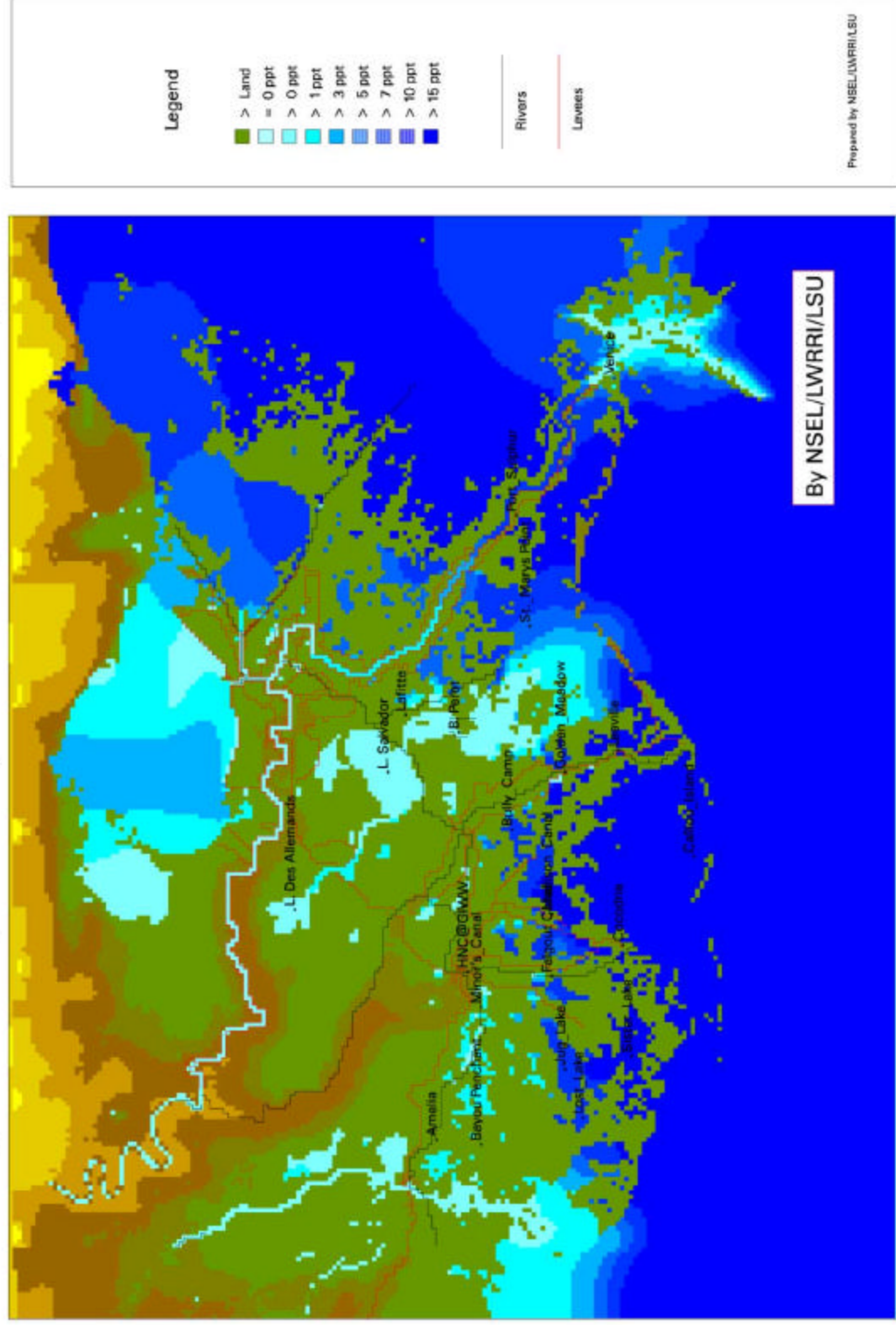
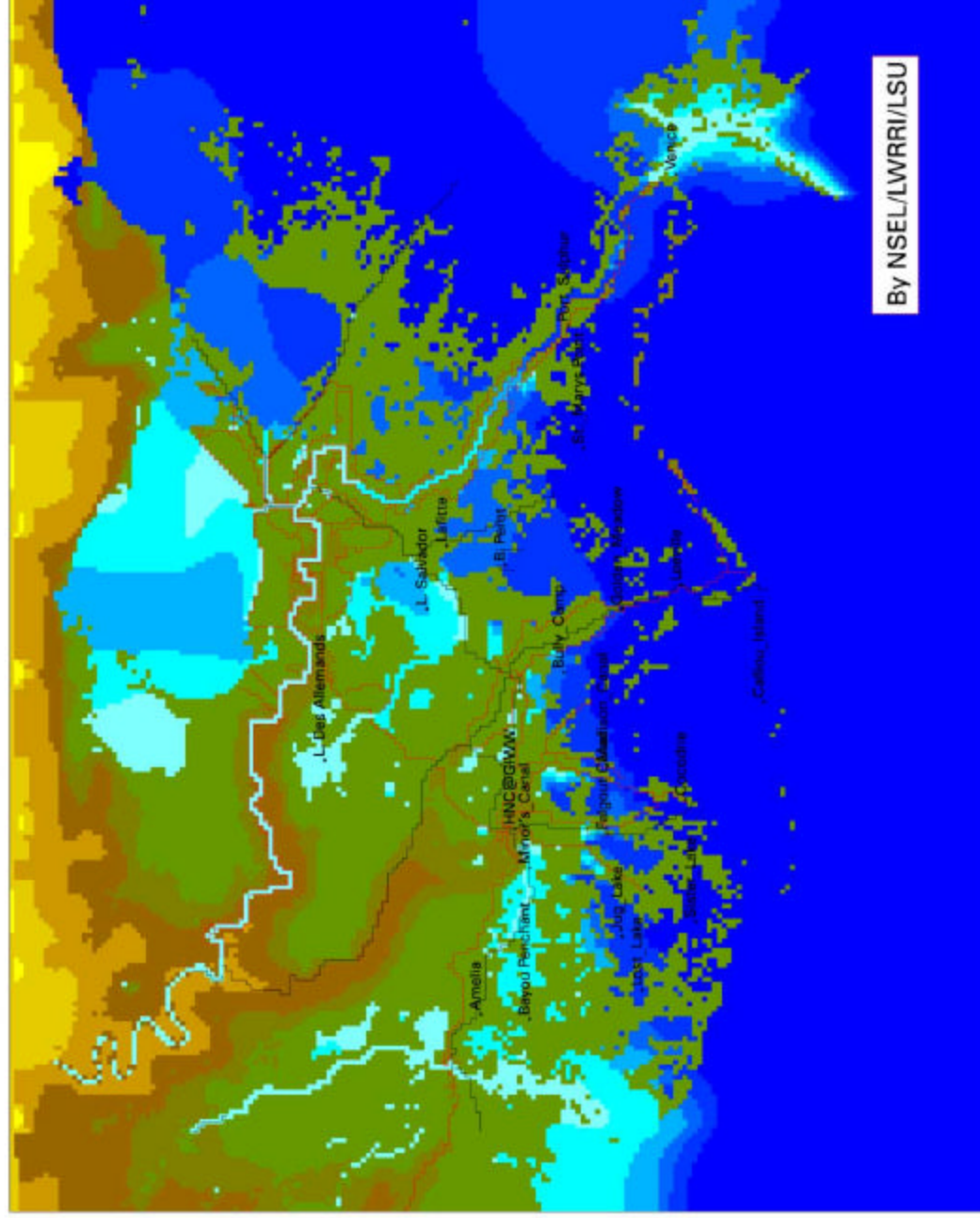
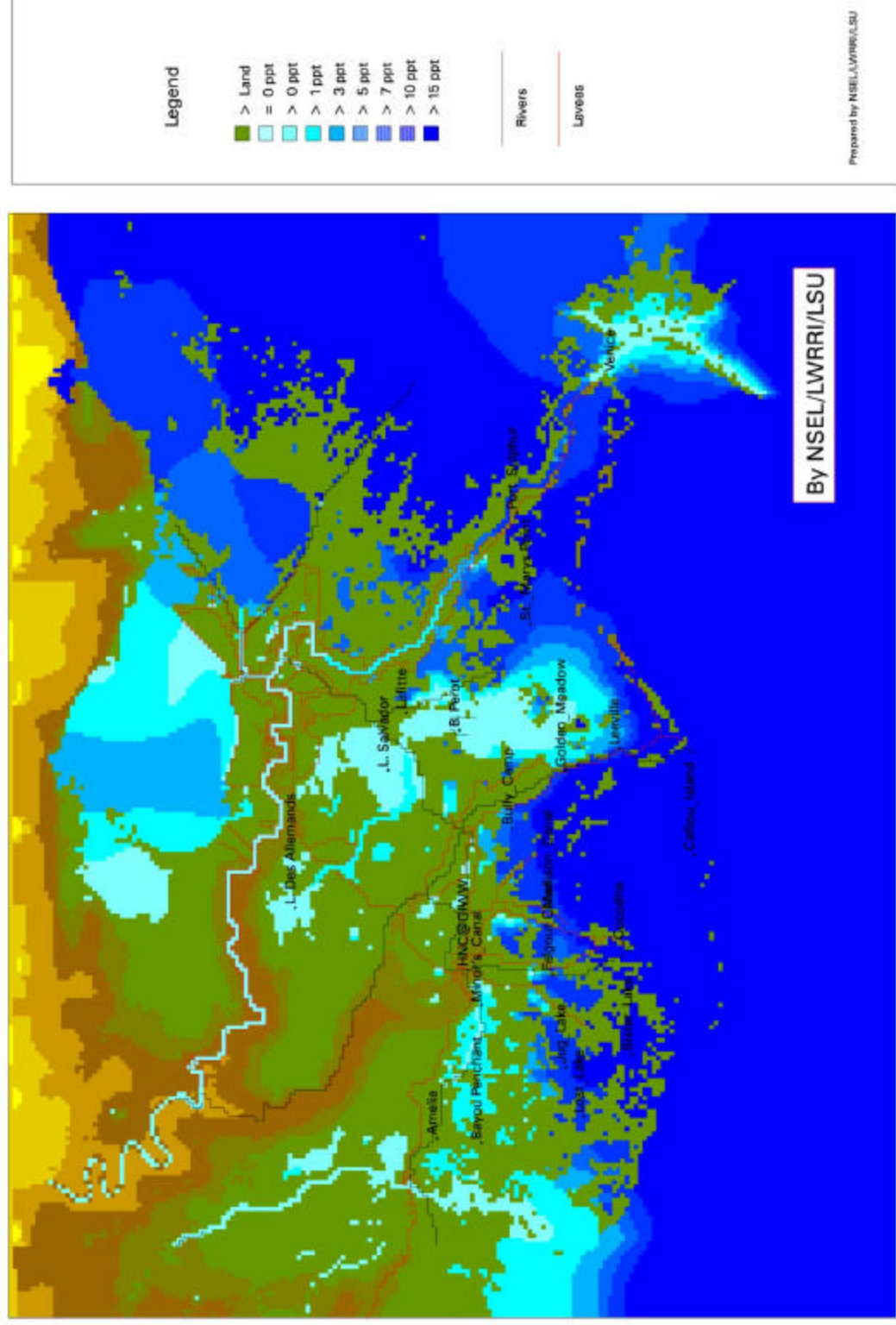


Figure 3-15. Salinity Distribution (w/o Davis Pond, 100-Year, No-Action)



Time = 2160 Hr. (90 Days)

Figure 3-16. Salinity Distribution (with Davis Pond, 100-Year, No-Action)



Time = 2160 Hr. (90 Days)

Figure 3-17. Salinity Difference (w/o Davis Pond, 30-Year, Alternative 1 vs. No-Action)

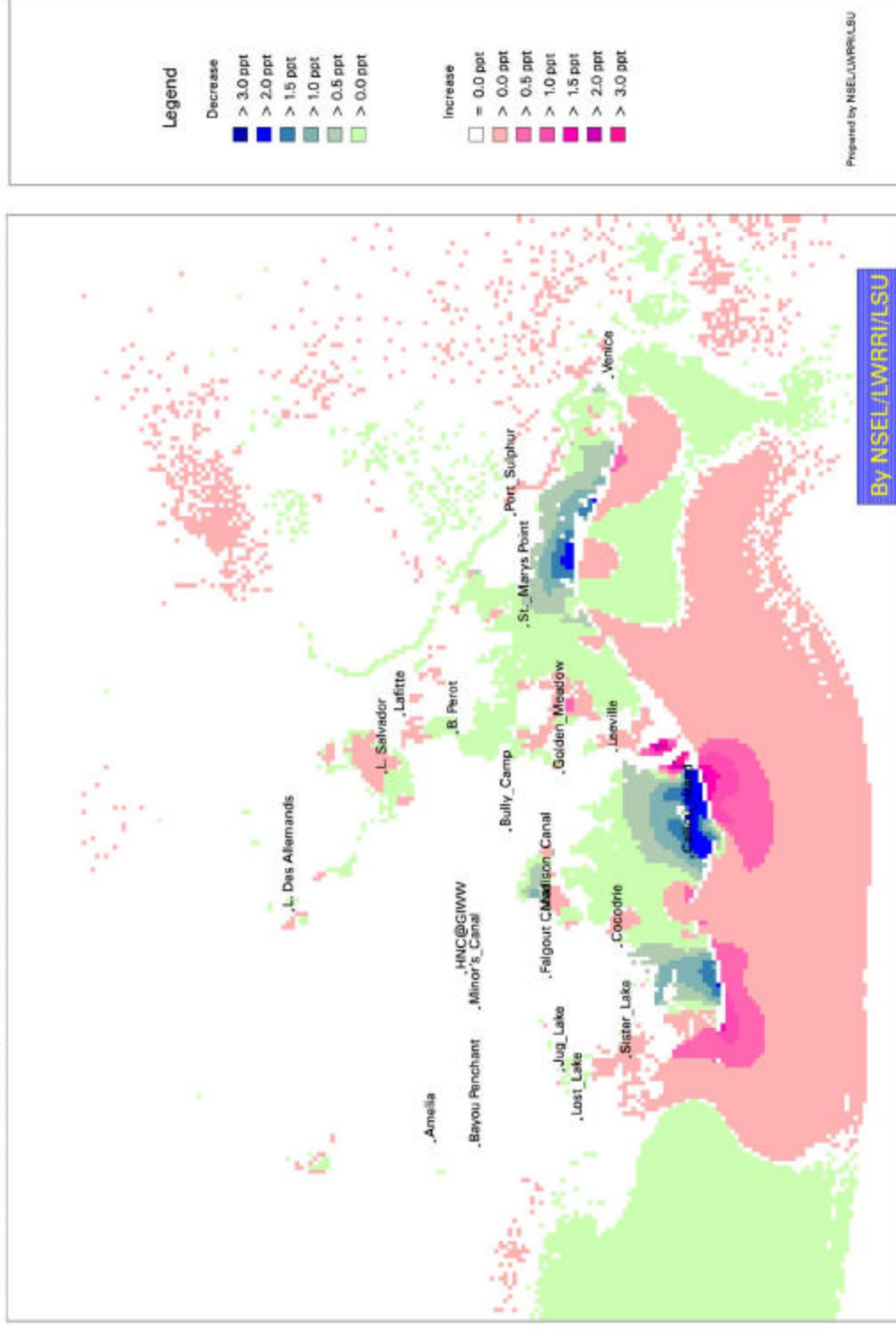
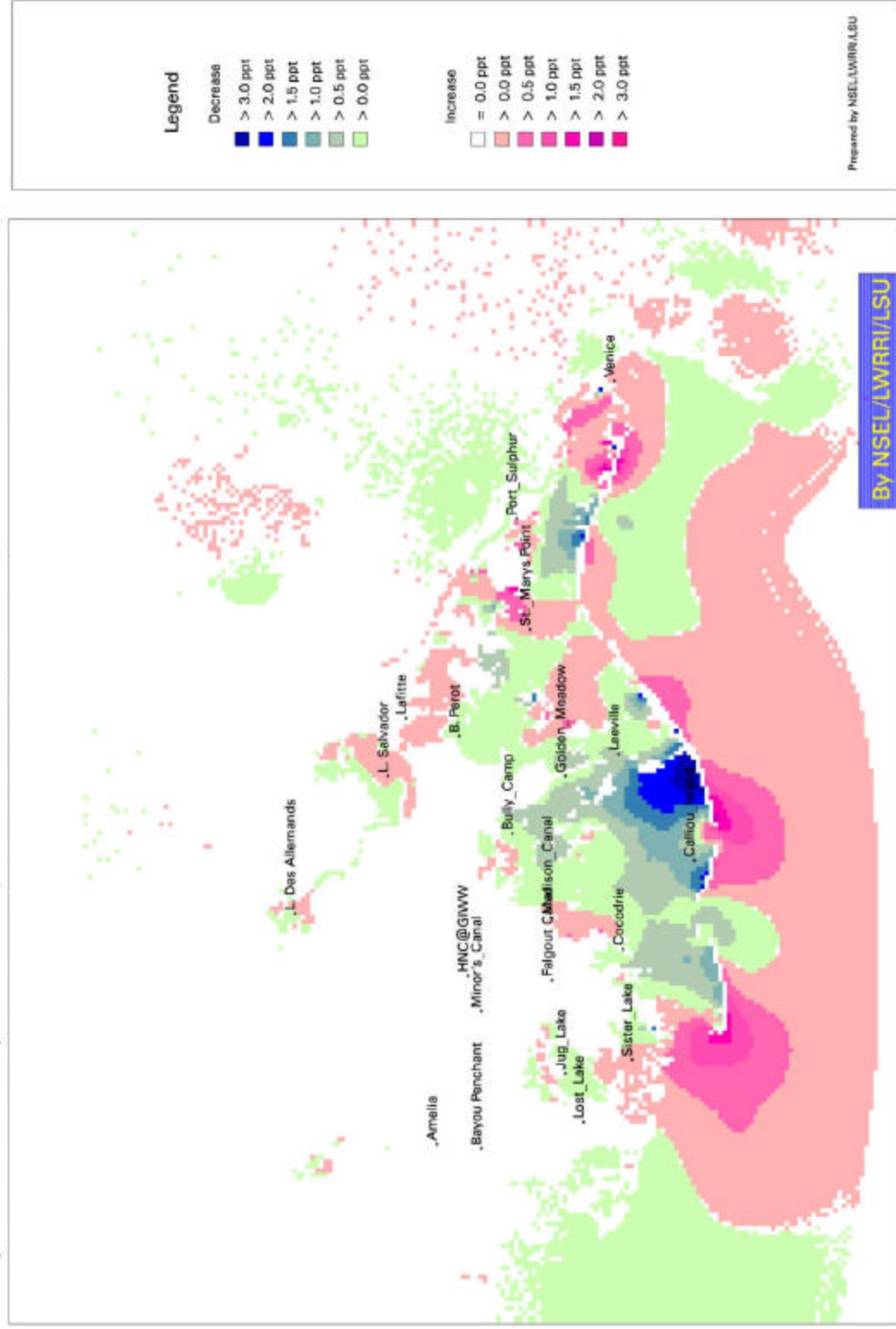


Figure 3-18. Salinity Difference (w/o Davis Pond, 100-Year, Alternative 1 vs. No-Action)



Time = 2160 Hr. (90 Days)

Figure 3-19. Salinity Difference (with Davis Pond, 30-Year, Alternative 1 vs. No-Action)

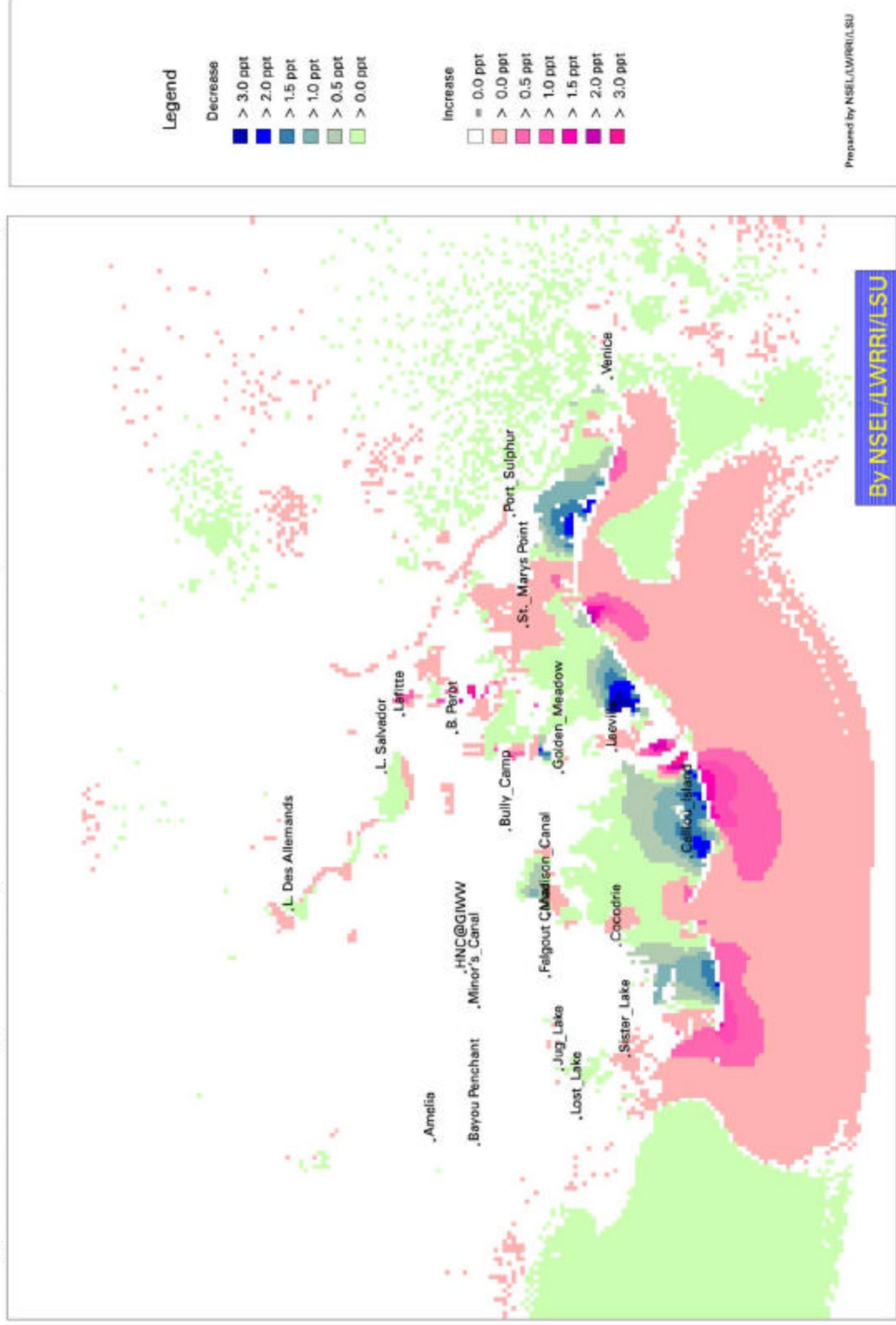
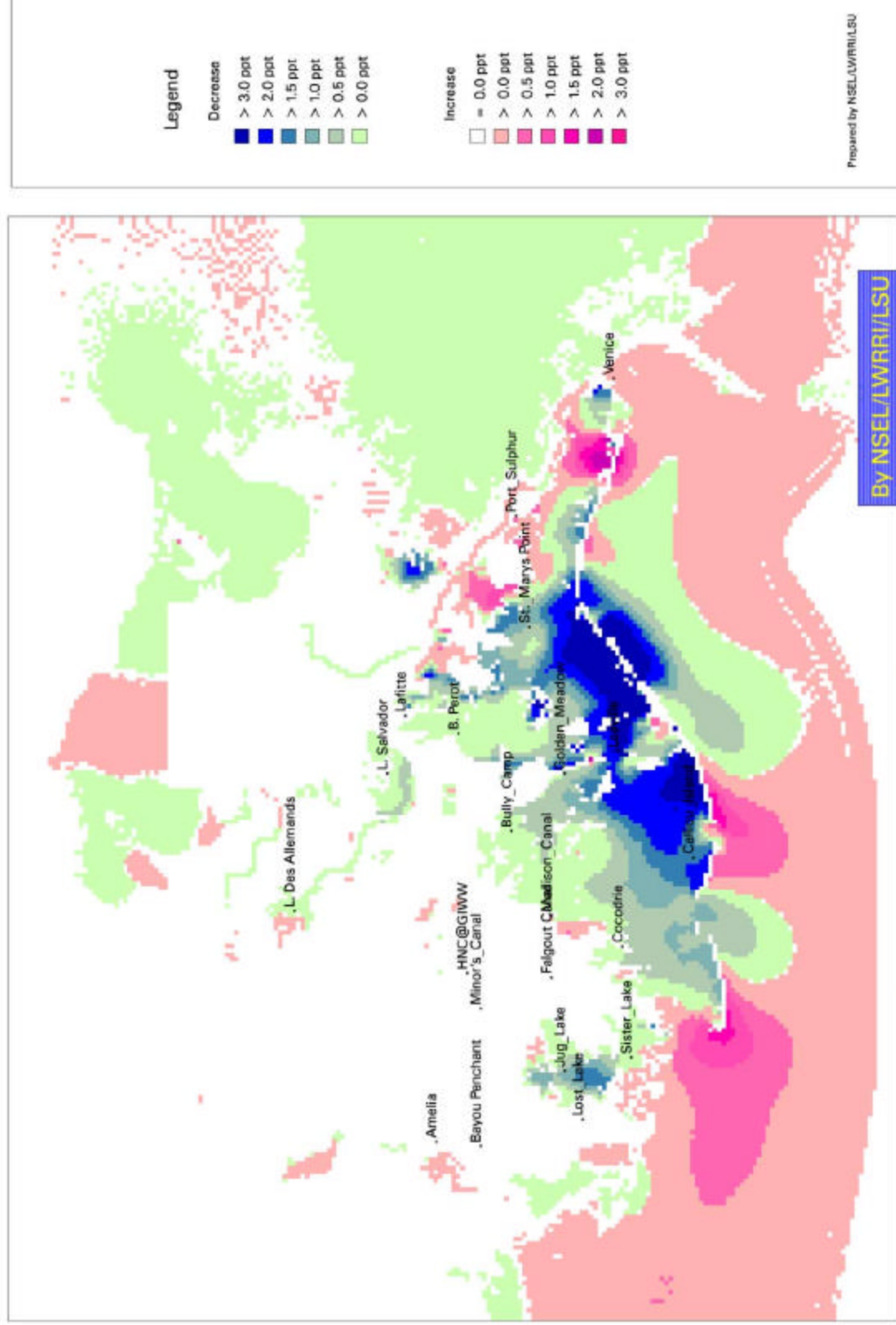


Figure 3-20. Salinity Difference (with Davis Pond, 100-Year, Alternative 1 vs. No-Action)



3.2.2.3. Alternative 2

Alternative 2 shows similar patterns of changes in salinity as Alternative 1, (i.e., the changes occur near the islands). Figure 3-21 shows the area immediately north of Timbalier Island would experience a salinity reduction of over 3 ppt in 30 years. In 100-years, the effects of Alternative 2 on the bay salinities are minor, as shown in Figure 3-22. When Davis Pond is operated, the combined effect is to decrease salinity in the southern part of Barataria Bay and increase salinities in the bay's northern section, as shown in Figures 3-23 and 3-24.

3.2.3. Hurricane Simulations

Assessments of the effects of the barrier island alternative on extreme hydrologic conditions were made by running the hydrologic model with a Category 5 hurricane. This condition represents the greatest hydrologic threat to the natural and economic resources in the study area. Hurricane simulations were run for no-action and compared with implementation of Alternatives 1 and 2. The simulations included wetland landscape for present, 30-, and 100-year conditions.

The same hurricane storm was selected for the alternative evaluations as was used in the no-action simulations reported in the Step G document (LADNR 1998g). The hurricane selected represented the hurricane of record for the study area. The storm had a central pressure of 752 mm of mercury (29.6 inches Hg), a forward speed of 3.86 m/s (8.6 m.p.h.), a radius to maximum winds of 40.8 km (25.4 miles) and a direction of movement that was due north. The radius and track direction are average values for all hurricanes affecting the study area. The forward velocity is the speed for which 25% of the historical storms had a lower velocity. The central pressure puts the storm in the Category 5 on the Saffir/Simpson Hurricane Scale and is similar in intensity to Hurricane Camille. Storms propagating along two paths were simulated in the modeling. The first hurricane path, Track 1, is shown in Figure 3-25 and had a forward direction along

longitude 90W degrees 30 minutes. The largest storm surge associated with Track 1 was in the Barataria basin. Track 2, shown in Figure 3-26, had a forward direction along longitude 91W degrees 30 minutes. The largest storm surge associated with Track 2 is in the Terrebonne basin.

Figure 3-21. Salinity Difference (w/o Davis Pond, 30-Year, Alternative 2 vs. No-Action)

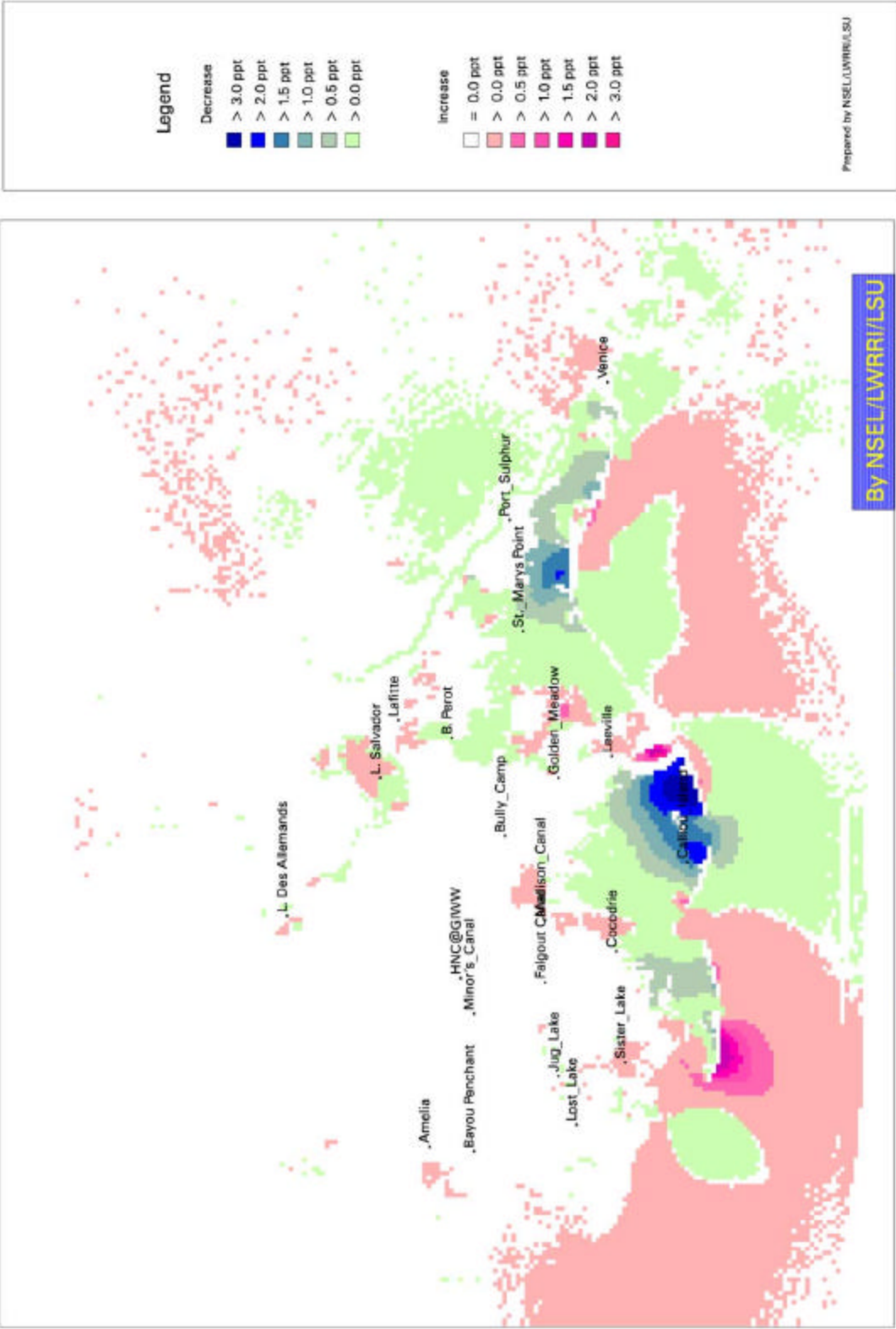


Figure 3-22. Salinity Difference (w/o Davis Pond, 100-Year, Alternative 2 vs. No-Action)

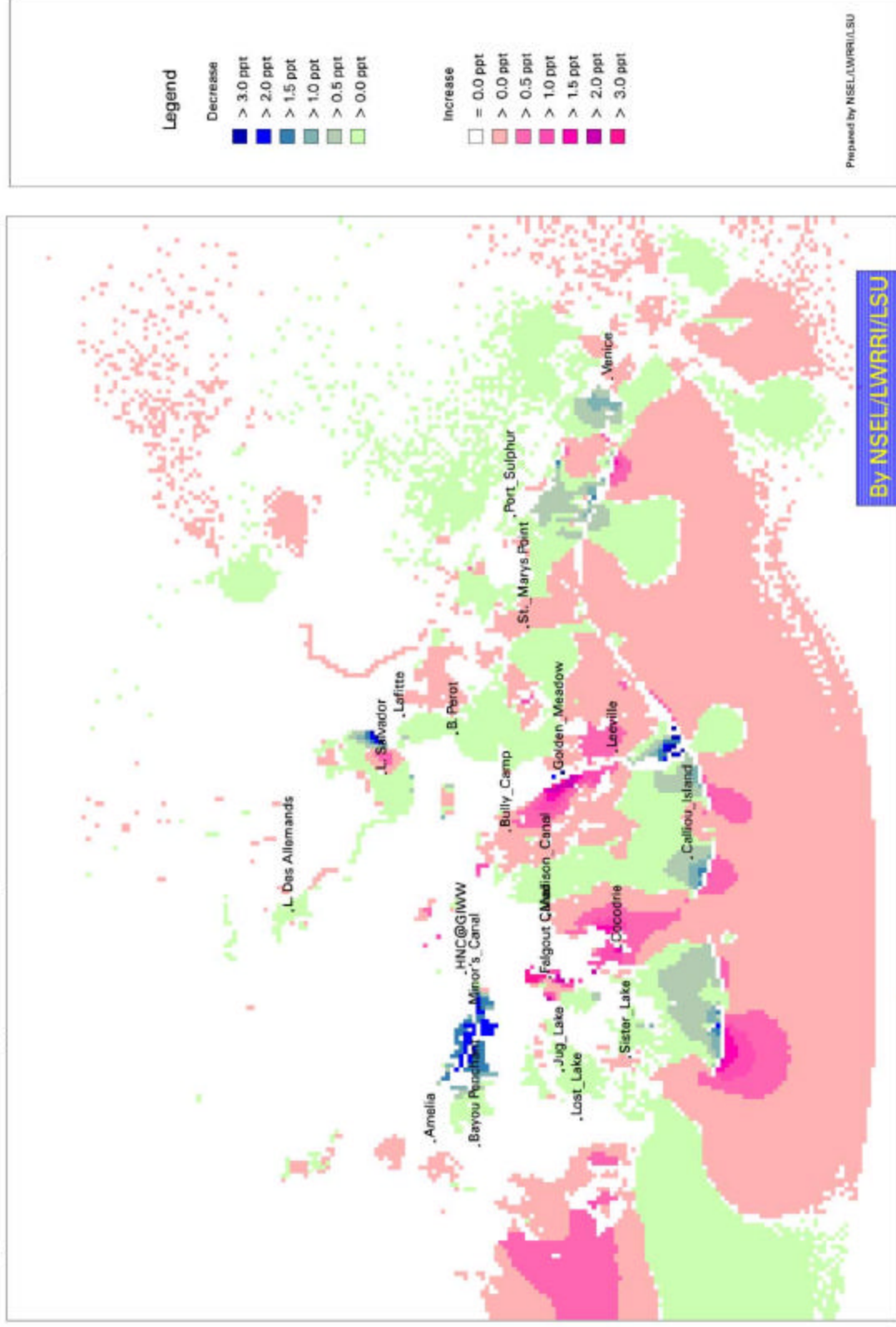


Figure 3-23. Salinity Difference (with Davis Pond, 30-Year, Alternative 2 vs. No-Action)

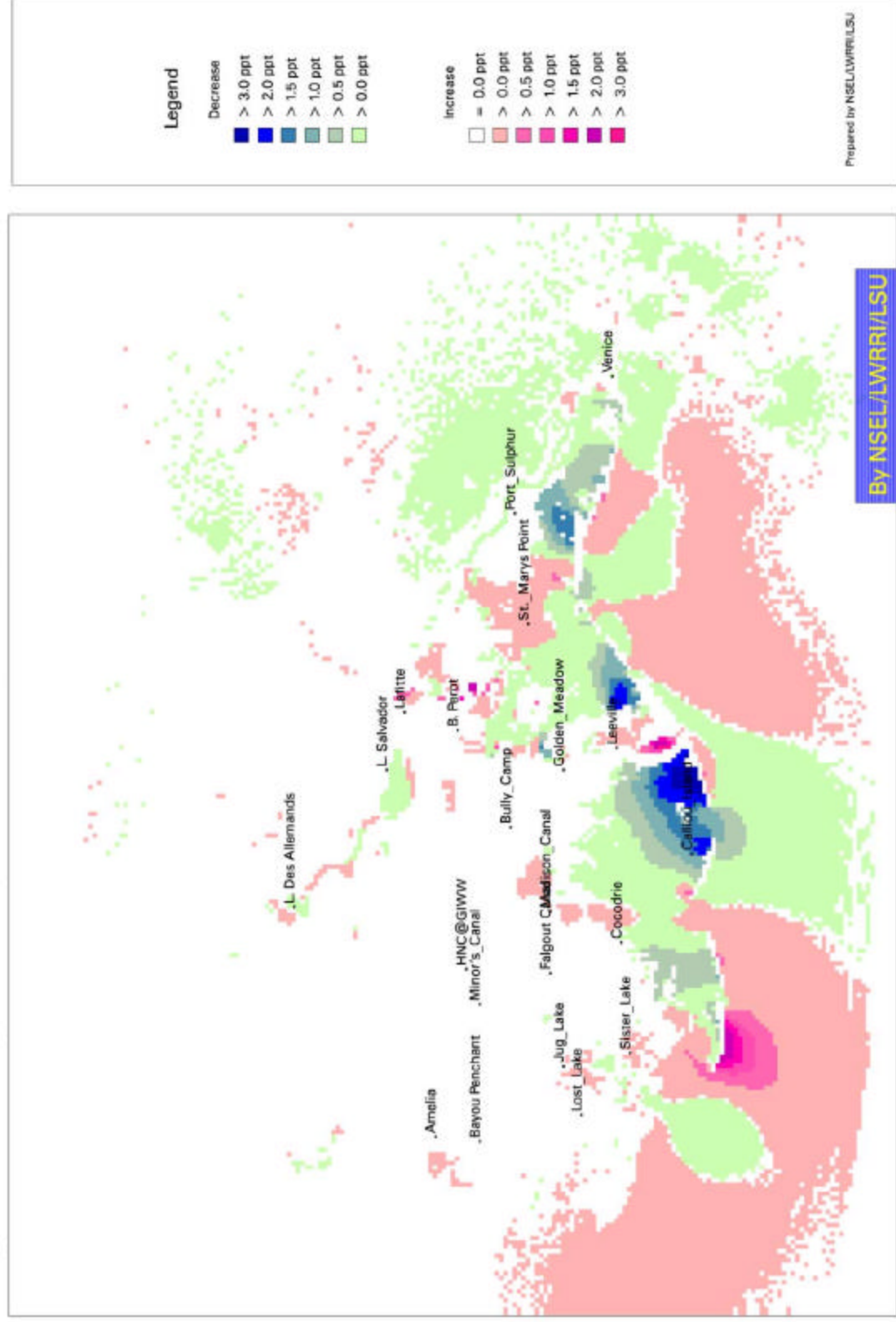


Figure 3-24. Salinity Difference (with Davis Pond, 100-Year, Alternative 2 vs. No-Action)

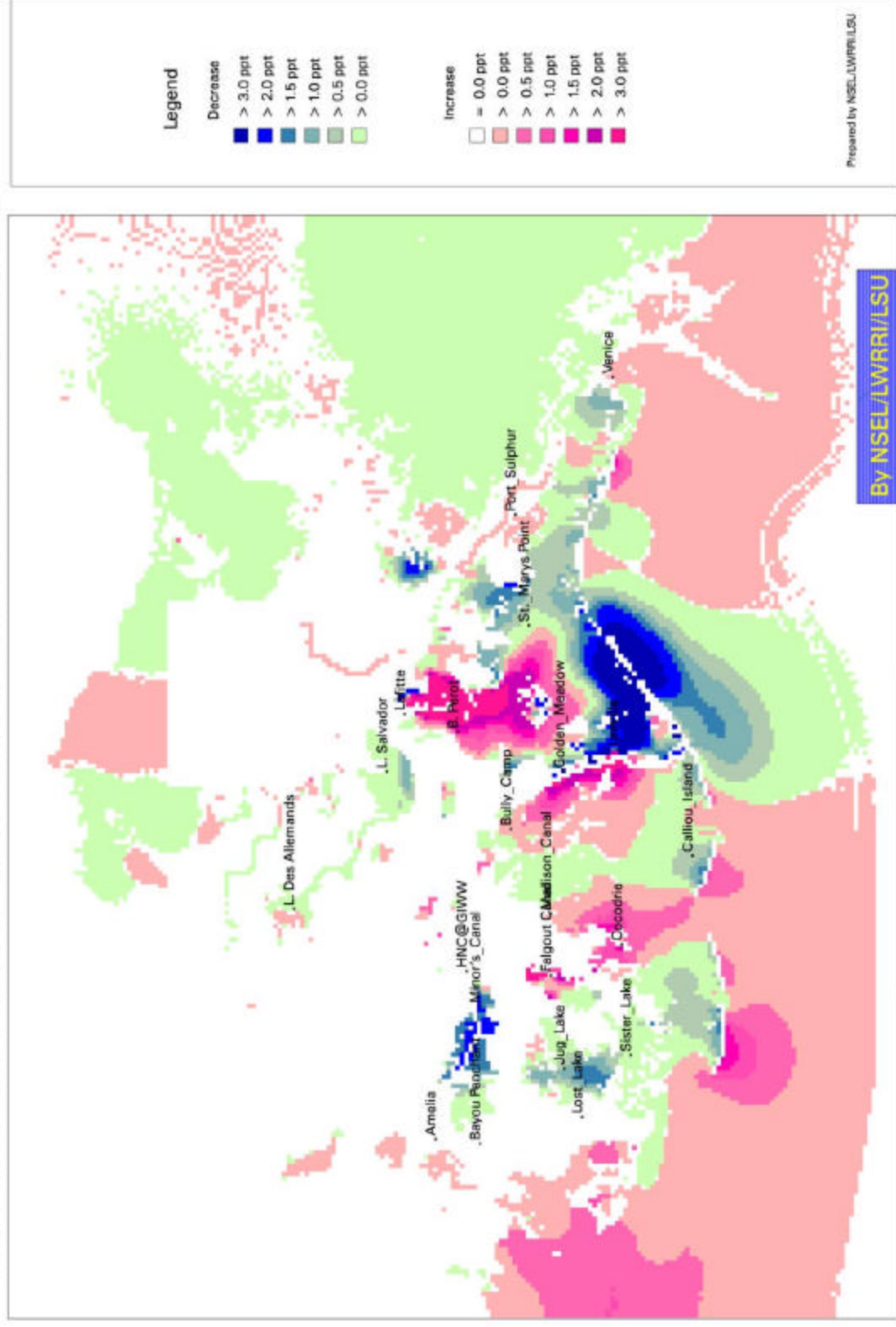


Figure 3-25. Maximum Water Level Elevation (Present, No-Action, Track 1)

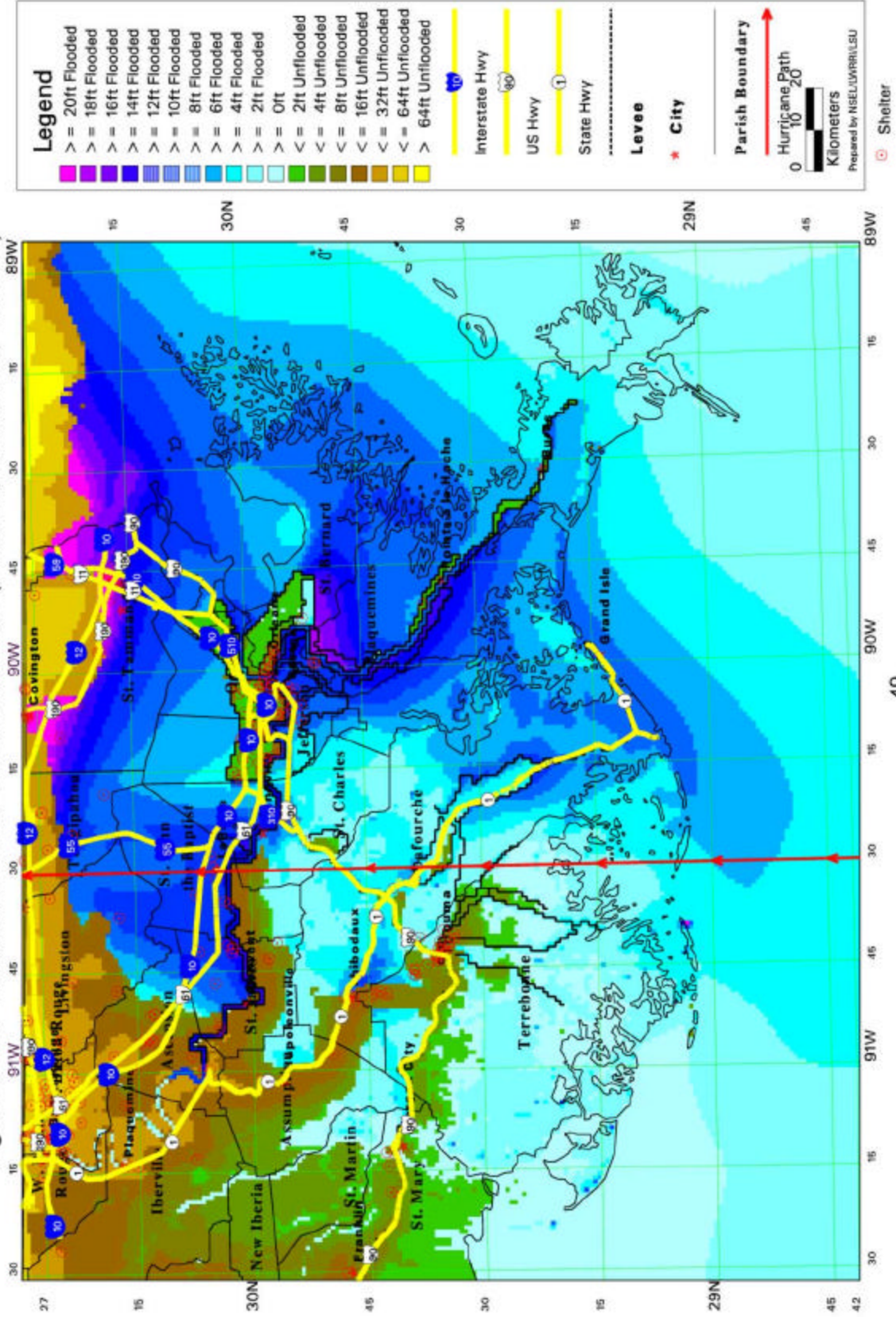
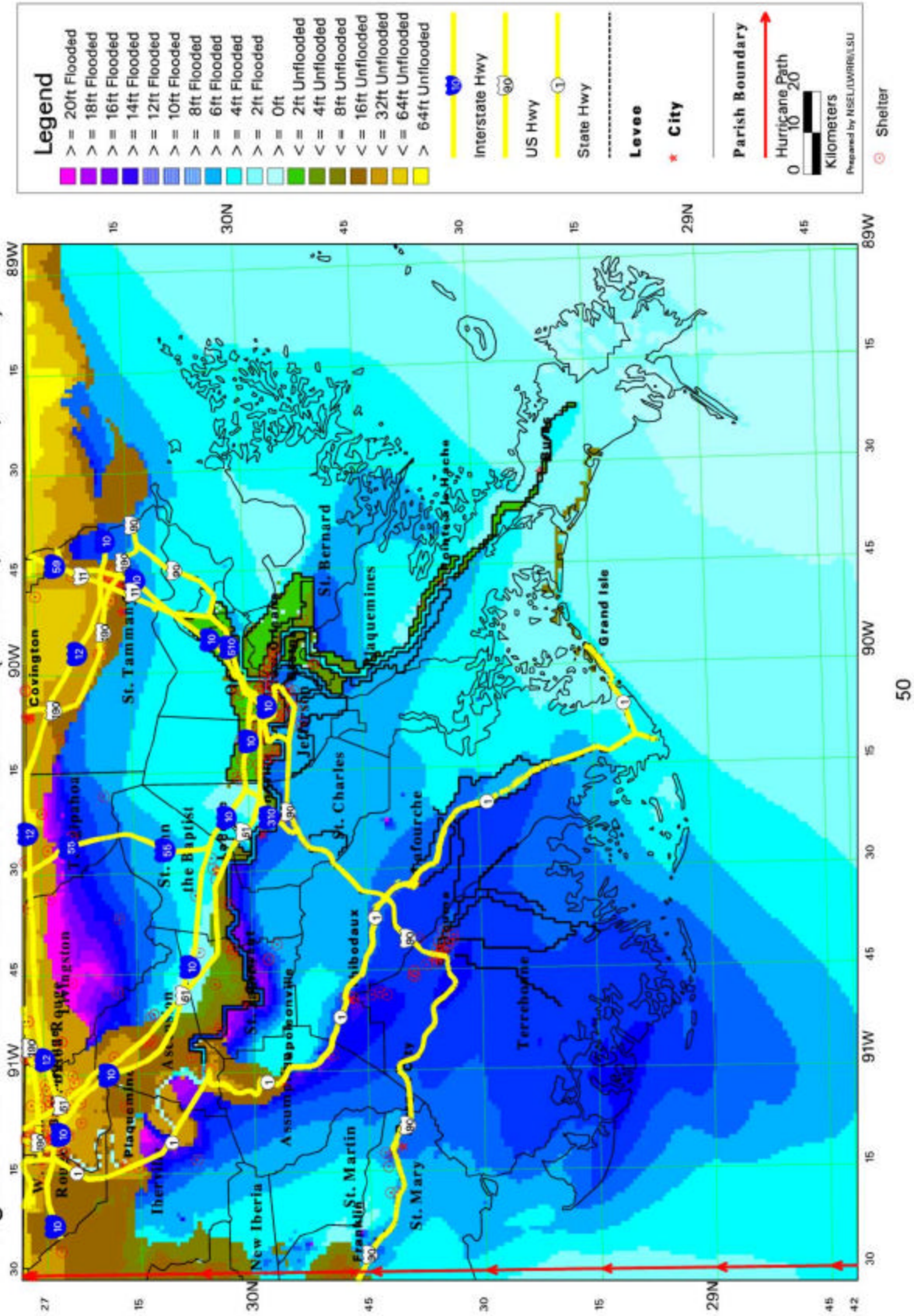


Figure 3-26. Maximum Water Level Elevation (Present, No-Action, Track 2)



The no-action simulations indicate that the islands are already degraded and that there will be a slight increase in maximum hurricane flood elevation due to the future loss of the barrier islands and the coastal wetlands. This increase was generally less than 10%.

The results of the hurricane simulations indicate the effects of Alternatives 1 and 2 are to generally reduce flooding in the study area. The general pattern of flooding (i.e., the coastal area flooded) remains essentially the same, with the main difference being the depth of flooding. The maximum flood elevations for the various time series locations are summarized in Tables 3-3 and 3-4. These tables depict the maximum flood elevation averaged between the present, 30- and 100-year time periods due to the similar water levels for each wetland configuration.

The track 1 simulations indicate that both barrier alternatives would reduce hurricane flooding in the Barataria basin and in the eastern side of the Terrebonne basin. Certain areas in the Terrebonne Basin, such as Caillou Island, have a reduction in flood elevation greater than 50%. Very little reduction is indicated for Cocodrie, Golden Meadow, and Venice.

The track 2 simulations indicate that both barrier alternatives would reduce hurricane flooding in both the Barataria and Terrebonne basins. Little reduction is indicated for Amelia, Bayou Penchant, Golden Meadow, the Houma Navigation Canal at the GIWW, Jug Lake, Lost Lake, Minor's Canal, and Sister Lake.

Table 3-3. Average* maximum flood elevation for the Track 1 hurricane (meters)

Location	No-action	Alternative 1	Alternative 2
Bully Camp	1.80	1.10	1.30
Caillou Island	1.40	0.50	0.95
Cocodrie	1.15	1.10	1.15
Golden Meadow	1.80	1.65	1.70
Lafitte	2.75	1.75	2.20
Lake Salvador	1.20	0.55	0.80
Leeville	2.10	1.45	1.60
Port Sulphur	3.30	2.20	2.40
St. Mary's Point	2.40	1.00	1.70
South Bayou Perot	2.00	1.30	1.70
Venice	1.35	1.20	1.25

* Average of present, 30- and 100-year
1 meter = 3.28 feet

Table 3-4. Average* maximum flood elevation for the Track 2 hurricane (meters)

Location	No-action	Alternative 1	Alternative 2
Amelia	2.65	2.55	2.55
Bully Camp	3.25	2.55	2.80
Bayou Penchant	2.45	2.45	2.45
Cocodrie	2.90	2.10	2.50
Falgout Canal	3.00	2.50	2.70
Golden Meadow	1.65	1.40	1.65
Houma Navigation Canal	3.40	3.10	3.25
Jug Lake	3.35	3.10	3.15
Lafitte	1.80	1.25	1.50
Lac des Allemands	2.30	1.90	1.95
Lake Salvador	1.85	1.40	1.60
Leeville	1.55	1.05	1.30
Lost Lake	3.00	2.80	2.85
Madison Canal	2.70	2.00	2.30
Minor's Canal	3.45	3.10	3.20
Port Sulphur	1.55	1.25	1.25
Sister Lake	3.45	3.10	3.15
South Bayou Perot	1.55	1.10	1.25

* Average of present, 30- and 100-year
1 meter = 3.28 feet

Figure 3-27. Average maximum flood elevation for the Track 1

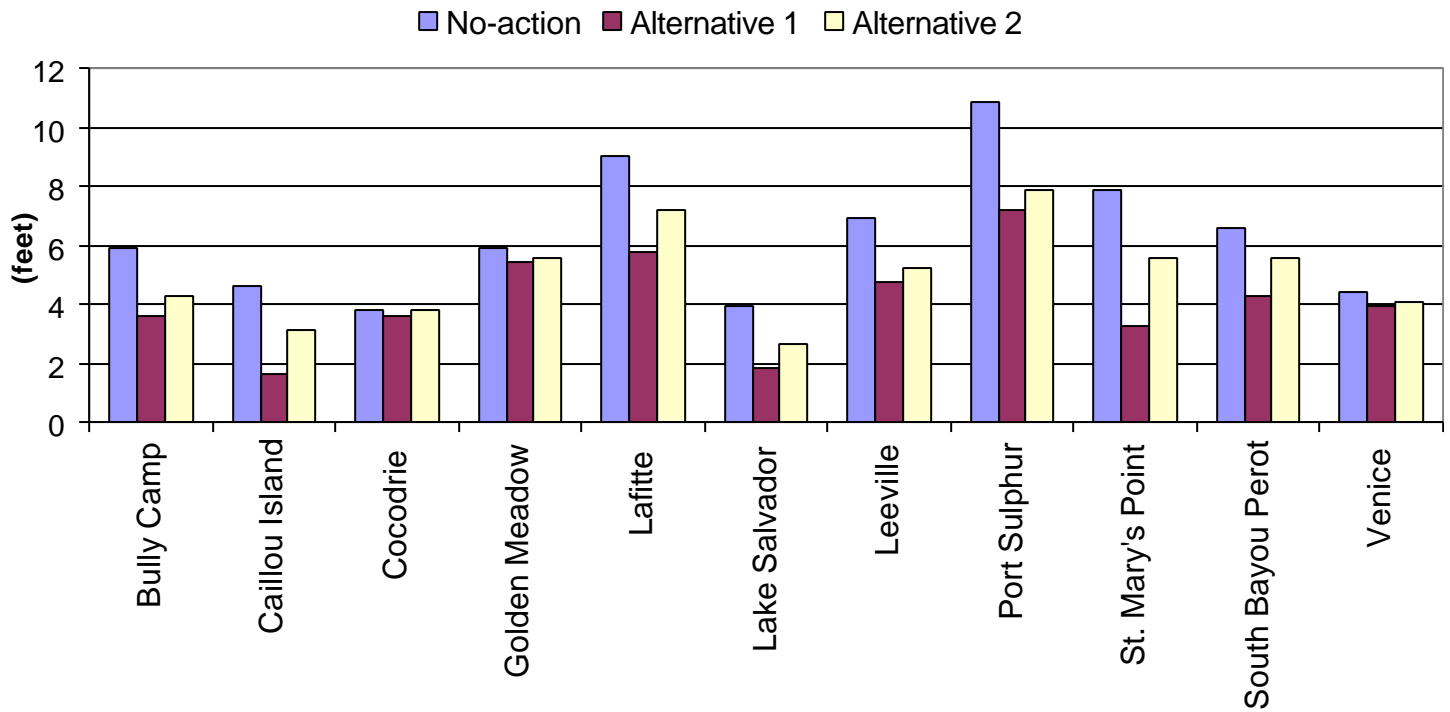


Figure 3-28. Average maximum flood elevation for the Track 2

